Sea Frontiers

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Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

November, 1958

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AT FIRST GLANCE *this might be an albino palm tree, uprooted by a hurricane, but it is not even related to plants, although one of its common names is "sea lily." This fine specimen of a stalked crinoid was dredged from the depths of the Tongue of the Ocean, Bahamas. It is an animal of ancient lineage, related to the starfish and sea urchins. (Walter R. Courtenay)*

FRONT COVER. *Lowering a Nansen bottle from the research vessel* Crawford. *From water samples collected by such equipment scientists are obtaining data which sheds important new light on the circulation and "age" of the little known waters of the deep sea. (Woods Hole Oceanographic Institution)*

BACK COVER. *Nubble Light, York, Maine, is one of the most photographed and painted beacons along the Atlantic coast. Its stubby white tower rises from the rocky shoreline south of Portland. (Charles E. Lane)*

SEA FRONTIERS

Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

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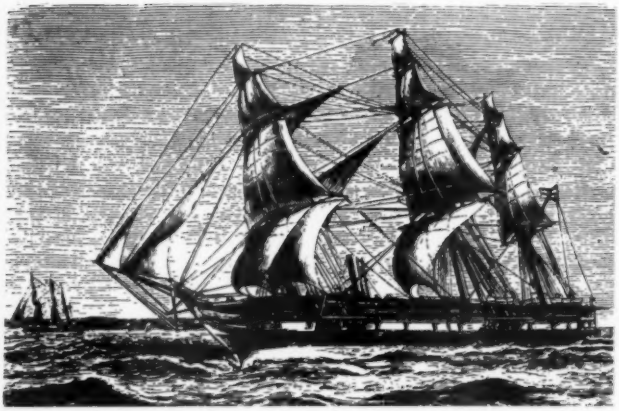
Table of Contents



VOLUME 4, NO. 4 NOVEMBER, 1958

		PAGE
Feast or Famine?	Editorial	194
Ambergris—Neptune's Treasure	C. P. Idyll	201
Gulf and Caribbean Fisheries Institute and Game Fish Conference		210
Most Ominous Wave!	E. John Long	212
Sharks Are Useful	Alfred Volpe	224
Satellites and Oceanography		232
How Old Do Fish Grow?	Robert W. Ellis	235
Stalking the Gray Ghosts		242
Watch for Tagged Tarpon!	John E. Randall	248
They Sought Foul Weather	Paul H. Oehser	250
Science of the Sea in Books	Book Reviews	252

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Feast Or Famine?

CAN THE EARTH produce sufficient food for the growing population of mankind? If not, is there any real prospect that the deficit can be made up by increased food from the sea? Judging from the contents of our mailbag, considerable confusion regarding these questions has arisen in the mind of the average person as a result of contradictory and exaggerated statements appearing in the popular press.

In the United States of America, farmers are being rewarded for NOT growing crops and penalized for producing too much food. The taxpayer pays the bill. He also pays part of the bill for a United Nations search to find ways of *increasing* the food supply of our planet. He reads articles in which the sea is regarded as a great untapped source of food, but meanwhile sees reports of declining production in a New England fishery. What is the truth?

Exploding Populations

The truth is not always a simple matter of black and white and, in fact, it often varies according to the viewpoint of the observer. Thus, there is no shortage of food in the United States today. But, looking at the world as a whole, the total amount of food produced is insufficient to provide an adequate diet for the present population, and there are enormous numbers of people in the poorly developed areas who are living on the verge of starvation. Again, though present day conditions are adequate, the population of North America is increasing at the rate of about 2 million per year. If it continues at the same rate there will come a time when the land must be exploited to its full extent to provide adequate food. From then on, unless agriculture is greatly improved or new sources of food are provided, the growing numbers of people will have progressively less to eat.

Limits to Land

Economists are apt to dismiss the problem with the assurance that agriculture will inevitably increase the yield of the land and will find ways of putting inferior land to use. There is a limit to the available land, but, even if we are prepared to sacrifice recreational areas such as parks and wildlife reserves, more land will also be taken up for the industrial and domestic needs of a growing population. No matter what technological magic may be evoked, there is an absolute limit to the crop production, based upon the amount of sunlight energy which falls upon the land.

Another argument which is popu-

LTHOUGH THERE IS NO SHORTAGE *of od in the United States today, millions people in poorly developed or overpulated parts of the world are living the verge of starvation. This aged hinese grandmother, living on a samin Hong Kong harbor, is typical of me 700,000 refugees and escapees om the Communist dominated mainnd. Many of them would have no food all except for foreign charitable orizations, such as CARE. (Cooperive for American Remittances to verywhere, Inc.)*

FISHING CALLS FOR HARDY, ADVENTUROUS MEN. *Because there is a year round demand for fresh fish, boats and crew must expect any kind of weather, and sometimes real hardships, while harvesting the bounty of the sea. This sturdy vessel has just returned safely to Gloucester, Mass., laden with almost as much poundage of ice as fish. While the sea is one of the greatest untapped sources of food, marine scientists nevertheless are investigating declining production in some of the important fisheries of the world. (Massachusetts Department of Commerce)*

lar in today's rosy atmosphere of scientific and engineering progress is that food factories may one day replace natural farmland. The prospect of ever doing this economically is very remote.

Solution Discarded

With the world's population expanding at the colossal rate of 100,000 per day and a finite limit to the food potentials of the land there remain two possible solutions, one of which is a rational and equitable system of birth control, universally applied. Least of the obstacles in the way of this supremely logical solution is that of religious prejudice. A far greater obstacle is that population growth has become almost an instrument of racial and national aggression. Crowded populations must either emigrate to the less crowded countries, or subjugate them by warfare. The policies of Hitler, Mussolini and other dictators, no matter how repugnant, at least recognized the realities.

The second possible solution is to look to the remaining 70% of the earth's surface, the ocean. What is

ONE OF THE FOOD POTENTIALS *of the ocean is seaweed, but this vegetable harvest is relatively negligible. Seaweeds are used for food in Japan and a few other places, but more are used as raw materials for manufacturing, fertilizing, and medicinal purposes. At this Rockland, Maine, plant seaweed is processed into algin, a white powder of many uses. (Algin Corporation of America).*

realistic estimate of its food potentialities? At first sight it would appear that, because of its great extent, over twice the surface covered by land, its production of food should be twice that of the land. Much of the land is desert or mountain or in other ways not adaptable to agriculture, so that a surprisingly low proportion of land actually produces food. The ocean therefore should have food potentials still greater in proportion to the land. In terms of the tiny vegetable growth or plankton of the seas, scientists have estimated that the total production of the ocean is somewhere between five and ten times that of vegetable crops on land.

Three Hundred Billion Tons

How much of this great food potential of the sea is actually realized? The facts are discouraging. In the first place the vegetable harvest is almost negligible. Seaweeds are used for food in Japan and elsewhere but more are used as raw materials for manufacturing and medicinal purposes. In any

FOOD OF THE FUTURE? *The main bulk of vegetable life in the sea is the microscopic plankton, which over the entire oceans has been estimated to yield as much as 300 billion tons of plant starches each year. Yet none of this is harvested. However, vegetable plankton is the food of these small grazing sea animals called zooplankton, which in turn are eaten by fishes. (Marine Laboratory, University of Miami)*

case the total yield is small. The main bulk of vegetable life in the sea is the microscopic plankton, which over the entire ocean has been estimated to yield as much as 300 billion tons of plant starches each year. None of this is harvested. Instead, the plankton becomes food for small grazing sea animals, which in turn are eaten by fishes. This process is similar to the manner in which the land grasses are converted to beef by grazing cattle.

Turning then to animal proteins, the potential yield of fishfood from the sea has been estimated as one billion tons annually. This may be too high, but even if we accept the more conservative figure of 500 million, it is many times higher than the beef productivity of land.

Fish and Flesh

The actual yields are again disappointing. The world's meat production is about 50 million tons. The world catch of fish is only about 25 million tons. This is half of the present day meat production and one-twentieth of the estimated fish potential of the sea.

Obviously there must be good reasons for our failure to utilize more than five per cent of the seafood potential. It is natural to ask what prospects exist for doing better in the future.

Untapped Southern Seas

There are a number of factors involved. The major fisheries of the Northern Atlantic and Pacific account for the greater part of the present catch. But they occupy a relatively small part of the ocean. In fact about 90 per cent of the total catch is from the northern hemisphere, despite the fact that the northern oceans are only two-thirds as extensive as those below the equator.

Although there are about 20,000 species of fishes, the major fisheries use less than fifty of them.

The oyster and clam fisheries are probably far less productive than they could be, if suitable cultivation methods were developed and used more extensively.

Research Needed

The future yield of the sea, as far as fishes are concerned, is potentially great. To exploit this, it will be necessary to devise improved methods of

COMMERCIAL FISHES ARE WHERE *you find them, and not always far at sea. Few New Yorkers know that a flourishing shad business is carried on within the shadow of their skyscrapers. Here gill nets, heavy with fish, are being hauled from the Hudson River. That is the George Washington Bridge in the background. (U.S. Fish & Wildlife Service)*

finding the fish and of catching them. It will also be necessary to solve problems of transportation and handling, of marketing and of accustoming large sections of the human population to a fish diet. These few words, however, cover an enormous number of technical problems.

In order to accomplish these ends we need first of all the basic research of marine scientists, and secondly their application of new knowledge to the problems of finding, catching and marketing. Unfortunately we spend far less upon this type of research than we do upon agriculture, in spite of the vastly greater rewards.

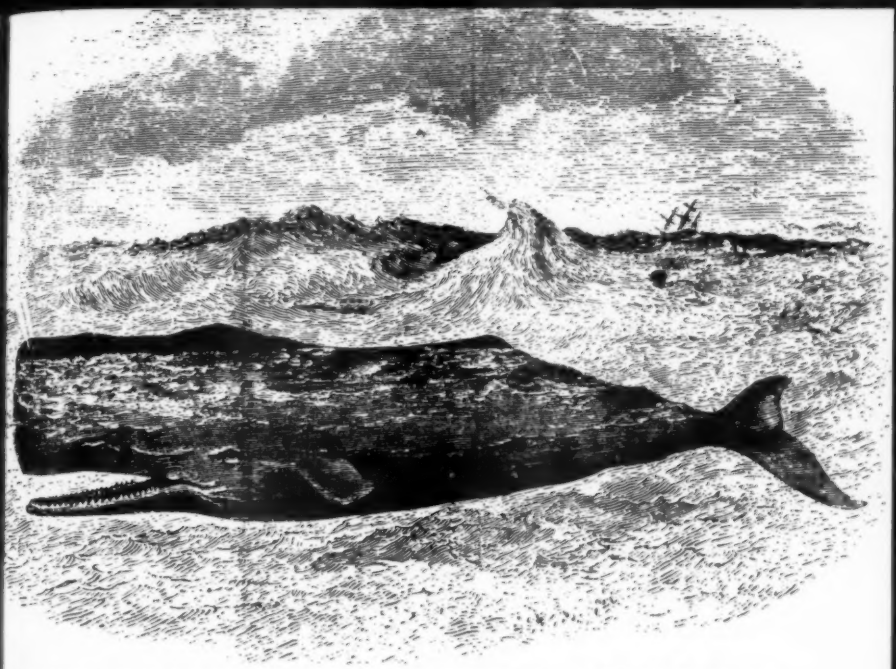
New Break-through Wanted

A question that is periodically raised cannot be ignored. If we were able to utilize plankton directly either as animal food or as human food, the potential yield would be more than a hundred times greater than that of fishing. So far this has not been accomplished and in the light of present knowledge the outlook is not very op-

BASIC TO THE DEVELOPMENT *of the world's fisheries is a knowledge of those fundamental conditions of the world's oceans which account for fluctuations in quantity and movement of the fishes themselves. Thousands of water samples, especially in such poorly-known areas as the Indian Ocean, must be taken before a detailed analysis can provide the necessary understanding. Dr. E. C. LaFond records temperatures while Mr. V. V. R. Vardachari reads the Nansen deep sea reversing thermometers aboard a research vessel in Indian waters. (E. C. LaFond)*

timistic. But in the search for knowledge it sometimes happens that new facts and ideas appear which may revolutionize our entire attitude. The probability, even the very thought of atomic energy would not have occurred to one until the unexpected discoveries of only a few years ago. A similar major break-through is not impossible in our attempts to exploit the food of the sea.

When we are finally able to exploit the vast resources of the ocean to their full extent, it is to be hoped that our economic and political understanding will also have developed so as to avoid rewarding fishermen for NOT catching fish.



THE SPERM WHALE IS THE SOLE SOURCE OF AMBERGRIS. *Precisely* how *the strange substance is formed, is still a matter of conjecture, but it turns up in the intestine of a few sperm whales,* (Physeter catodon), *in the form of unattached lumps of varying size. When cast out of the whale, ambergris looks like stones or pebbles, it is almost black in color, and may stink abominably. Later it becomes paler, old lumps being almost chalky white, and improves in odor. (From an old print)*

Ambergris — Neptune's Treasure

By C. P. IDYLL
Research Professor, The Marine Laboratory, University of Miami

THERE IS SOMETHING ludicrous and yet pathetic in the contemplation of a fond mother storing a hunk of decaying malodorous flotsam from the seashore in her refrigerator in the vain hope that it will be the means of paying for her son's education. The hope that inspired her action, and which prompts scores of people every day to pick up and treasure the most repulsive pieces of dead flesh, jellyfish, yellowed wax, rubber and hundreds of other objects tossed onto the beaches by the tides, is the expectation that they have found a piece of that romantic and improbable treasure from the sperm whale's intestine, ambergris.

The Marine Laboratory receives dozens of inquiring letters every week. Some are requests for the identification of queer sea creatures, others for

advice on buying shrimp boats, still others want information on "everything about the ocean." The fattest file of all concerns ambergris. Everybody from tots to retired oldsters have heard of ambergris, and have gained greatly exaggerated ideas of its cash value. But the lure of easy riches, to be casually picked up on the beach, appeals to all of us. If there is added the romantic overtones of ambergris, the beachcomber is easily led to transmute anything he cannot identify into this treasure.

Known for Ages

Interest in ambergris is by no means new. It is repeatedly mentioned in ancient oriental writings. Ideas of its origin are nearly as fantastic as the beliefs regarding its marvellous properties.

Very early the whale was recognized to be connected with the production of ambergris, but it was hard for observers to accept the leviathan as the primary source. Birds, trees, seals, crocodiles, and bees are among the creatures which were believed to be responsible, the whale simply swallowing their product.

Certain kinds of birds, especially those living on Madagascar, were supposed to produce dung which melted in the sun and ran into the sea. Another tale involved the birds of the Maldive Islands, a group of coral atolls in the Indian Ocean. Barbosa says that the natives here believed that "there are certain great fowls which alight on the cliffs and rocks of the sea, and there drop this ambergris, where it is tanned and softened by the wind, the sun and the rain, and pieces both great and small are torn by storms and tempests and fall into the sea until they are found or washed up on the strands or swallowed by whales."

Sperm Whale Sole Source

Just why the whale was regarded as incapable of manufacturing ambergris by himself seems unaccountable. And yet we know now that he is the sole source of this strange material. Precisely *how* it is formed is still a matter of conjecture, but it turns up in the intestine of the sperm whale, *Physeter catodon,* in the form of unattached lumps of varying size.

There is a good case to be made for the theory that squid, or cuttlefish, are connected with the production of ambergris, since the parrot-like beaks of these animals are usually found imbedded in the lumps. Squid beaks do not form a nucleus around which faecal material is impacted, as has

CONSIDERING HIS HUGE SIZE, *the sperm whale has a comparatively small, toothed mouth. In addition to being the sole source of ambergris, the sperm whale also yields a special oil, which, when refined, becomes the spermaceti wax of commerce, used in medicine and in the making of candles and cosmetics. (U. S. Fish & Wildlife)*

been stated, since the beaks are found in any position in the mass—and are sometimes missing entirely.

Other early writers declared that ambergris was the hardened faeces of the whale. Dr. Schwediawer in 1738, stated, for example, that "We may therefore define Ambergris as the preternaturally hardened dung or faeces of the sperm whale, mixed with some indigestible relics of its food."

This idea has been regarded by many recent writers with about the same amusement as the theories about Madagascar birds, yet Dr. Robert Clarke, the English whale expert, says, "I believe that Dr. Schwediawer was, quite simply, correct...Local increase in water absorption by the large intestine and the chemical transformation enacted by the resident intestinal bacteria, probably each play their part in the formation of ambergris from faeces impacted around some matrix of indigestible material."

Whale Not Always Sick

More observation is required on this point before any definitive statement about the exact manner of formation of ambergris can be made. The whale producing ambergris is not necessarily sick, as has been said, since perfectly normal whales have yielded lumps of this substance. Another theory, that only male whales produce ambergris, has also been shown to be false.

When ambergris is cast out by the whale it is usually in the form of stones or pebbles, rounded by the movement of the intestines. In the sea and on the shore it is usually broken up before it can be recognized. Lumps of ambergris would easily be mistaken for rocks, unless their weight or their soft texture betrayed them.

Ambergris has been found over a large part of the world, but since the sperm whale is, generally speaking, a warm and temperate water animal, most of the finds have been in the middle latitudes. The Bahamas, Brazil, Africa, Japan, Australia, the East Indies, Peru, Madagascar, the Moluccas—these are the sources mentioned most frequently.

Odor Gradually Improves

When ambergris emerges from the whale's intestine it is dark, almost black in color, of a sticky, bituminous nature. It stinks abominably, but as it spends more and more time in the water (floating on the surface due to its low specific gravity), it gradually improves in odor and lightens in color. When found, the color is usually pale golden to dark brown, with the oldest

HE HAS A BETTER CHANCE *of getting ambergris than the beachcomber. Most of the ambergris of commerce comes from the whaling industry, through the use of harpoon guns similar to that shown below. Of hundreds of samples of strange materials submitted to the Laboratory during the past sixteen years, only two have turned out to be genuine ambergris. (U. S. Fish & Wildlife)*

AMBERGRIS IN THE RAW *does not look very romantic, but it is used as a fixative in the finest and most expensive perfumes—hence its relatively high market value. Actually, ambergris adds almost nothing to the odor of the perfume itself, but has remarkable powers of maintaining the scent of the odorous constituents of the perfume. Ambergris impairs a subtle velvetiness unobtainable otherwise. (Albert J. Dillinger)*

lumps being chalky white. The latter are the most valuable.

From the foetid odor of the fresh material, ambergris changes progressively to a fishy smell, then to a sweetish musty odor reminiscent of the sea. Many curious adjectives have been applied to the odor of ambergris: "earthy, reminiscent of brazil nuts," "musky," "a light sea odor," "an indole odor of the faecal type," "a moist incense odor."

Strange and Romantic Uses

The uses to which ambergris has been put are as strange and romantic as its real and imaginary origins. One modern use, at least in the Western world, is in the manufacture of perfume, but this was not always so. Formerly, it found its way into food, drink, medicines and tobacco. Its widest use was as an aphrodisiac.

Just how this dingy-looking material came to be credited with the power of heightening erotic desire is a mystery, and the man who first summoned enough courage to eat ambergris deserves to be remembered with that unknown hero who ate the first raw oyster. Whoever this worthy was, he soon had plenty of followers.

In the middle of the seventeenth century Sir John Chardin wrote that the Persians used musk and ambergris in abundance in several sorts of their sweetmeats and confections—the one (musk) only to fortify or strengthen, the other (ambergris) to stir up love, and which the people of condition seldom failed to eat both before and after

meals. It was especially valued by the Chinese, who as early as the thirteenth century, used to send as far as the east coast of Africa to get it, together with gold and ivory. They called it *lung yen*, or Dragon's saliva.

Ambergris was credited in India with power to assist women suffering from complications of childbirth, while the Chinese believed it assisted in the growth of marrow and semen. Several oriental peoples believed that it extended the span of life.

Many Other Uses

Other supposed medical virtues of ambergris are as varied as they are fascinating: a remedy for hydrophobia, epilepsy, typhoid fever, nervous diseases, gravel and for stoppage of the bowels. "It was formerly regarded as a cordial and antispasmodic like musk . . . a diuretic . . . gets rid of body parasites of tubercular patients and dispels ghosts." It was "able to dispel evil spirits and was used for devil possession and for asthma."

Everlasting Pill

Nor is this the end of the medical wonders attributed to ambergris. It was further said that it "eases the headache, takes away defluxions from the eyes, comforts old and aged people, prevents apoplexy and epilepsy, strengthens all parts of the body and causes fruitfulness." Leonard Stoller quotes another ancient writer to the effect that the Cantonese made ambergris into pills which were everlasting and could be chewed for years without diminishing in size.

It is interesting that the one modern use of ambergris, in fine perfumes, is somewhat related to its most outstanding ancient use—as an aphrodisiac. After all, the very names of today's perfumes suggest their seductive intent.

Acts as a Fixative

Ambergris can be used only in the finest and most expensive perfumes. Its action is as a fixative. It adds almost nothing to the odor of the perfume itself but has remarkable powers of maintaining the scent of the odorous constituents of the perfume. Musk in a perfume will give it the maximum diffusive power, while ambergris will give it the longest duration of evaporation. While perfumes prepared without ambergris last for days, those made with it will last for as many months, according to one expert. Ambergris imparts a subtle velvetiness unobtainable otherwise.

The starting material for the formation of ambergris is ambrein, which is present in some kinds of squid, eaten by sperm whales. Ambrein is a white solid, forming slender needle-like crystals which become highly electrified upon rubbing. In the presence of vanadium or copper and upon exposure to sunlight, air and seawater, it is transmuted into ambergris.

Synthetic Ambergris

Swiss and German chemists, after 30 years of research, have succeeded in creating ambrein artificially and it is on the market under the trade names of "Ambropur" and "Grisambrol." The two principal intermediate constituents have the formidable names of gamma-dihydroionone and ambreinolide. The former is responsible for the faint characteristic odor of am-

ONE OF THE LARGEST *pieces of ambergris ever found, this enormous chunk is more than a yard in diameter. Biggest on record was 5 feet, 5 inches long and 30 inches at its greatest diameter, and was taken from a sperm whale caught in the Antarctic in 1953. (J. Manheimer & Co.)*

bergris and the latter for its fixative qualities.

In 1956 the new synthetics sold for about one ninth the price of good quality natural ambergris and their price makes them available for use in cheaper perfumes. In addition, at least one firm is seriously investigating the aphrodisiac qualities of the synthesized material for its possible use in animal husbandry. This serves to prove how hard it is to kill old myths — or else to prove that the ancients were not as stupid as we sometimes like to believe!

With all its desirable characteristics, supposed and real, it is little wonder that ambergris has demanded a high price, especially in former times when the uses were more varied than they are today. A thousand years ago it was a familiar item of commerce in Africa and was classed with black slaves and gold as one of the important products of Maghreb, the ancient Arabic designation for the northern part of the Dark Continent. Ambergris was once literally worth its weight in gold. The East India Company normally paid between 50s. and 70s. per ounce—and in the valuable shillings of the 17th Century!

How Much Today?

In 1942 a perfumer is quoted as saying that ambergris was worth $20 an ounce, but if this were in fact true then, it certainly is not in 1958. It is, of course, impossible to state "the" price on the present market, since the quality of ambergris varies so greatly. In answer to an enquiry this year, four of the leading perfume manufacturers quoted the following ranges of prices per ounce: $2-$6, $3-$4, $4-$8 and $8-$9.

Most of the ambergris of commerce comes from the whaling industry and, as our correspondents put it, ". . . individuals connected with shipping." Some of the notable finds have occurred in recent years. Dr. Robert Clarke, the British scientist mentioned earlier, found a piece weighing 926 pounds in 1953. This enormous hunk of ambergris, 5 feet 5 inches long and 30 inches around in its greatest diameter, came from a 49-foot male sperm whale caught in the Antarctic. Dr. Clarke says this is the largest piece actually examined and authenticated. He lists four larger weights of ambergris mentioned in the literature, but regards three of them as probably comprising more than one piece. The fourth, weighing 982 pounds and reported by the Dutch East India Com-

pany in 1880, may be the largest single piece ever recorded.

Smaller, but still notable, finds of ambergris are numerous in the written accounts: a piece weighing 182 pounds purchased from the East India Company by the King of Thydore; a 280-pound piece from New Zealand; a 350-pound piece taken by a Norwegian whaler; 750 pounds from a whale in 1859, by a Nantucket whaler. A 53-pound piece found near Scotland was sold in London for $42,750. As late as 1956, a piece weighing 151 pounds, 8 ounces was sold in this country for $20,000.

So, not only is ambergris no longer worth its weight in gold, but to further explode the myth that it provides riches to be picked up on the beaches of the world, the chance of finding it there is extremely slim.

Each of four perfume firms answering a query stated that it was rare for an individual to find genuine ambergris. Said one, "In all my forty years' experience as a perfume chemist I have yet to meet an individual who has found real ambergris."

Finds in the Bahamas

Actually, people who have sent material to The Marine Laboratory in the last sixteen years have a little better record than that: two out of several hundred actually found the real thing. Both of these finds were in the Bahamas; one was a tiny piece weighing less than an ounce, while the other was much more worthwhile. This latter weighed about 200 pounds, consisting of one chunk of about 125 pounds and numerous smaller pieces. It was found by Samuel Nixon, of Inagua, Bahamas, in early 1955 and was sold to a Nassau firm for £500.

But for each of these two finds—one insignificant and one valuable—there have been hundreds of blanks drawn by the beachcombers. To save disappointment and to leave our chemists some time for their work, the Laboratory has established a charge of $5 per sample for testing supposed ambergris.

How to Test

In addition a bulletin is issued describing tests which can be applied in identifying ambergris. Positive identification is the job of an expert and even the best of these can sometimes be fooled. E. W. Bovill, who had intimate association with ambergris for many years as a dealer in the substance, relates how he and A. C. Stirling, another world authority on ambergris, paid a considerable sum for what they thought was a small piece of the valuable white variety—only to find on breaking it that it had a wick, and was a piece of wax candle, much weathered by the sea!

Despite the difficulties of foolproof identification, even a layman, by applying the tests below can eliminate at least 95 per cent of what he might hopefully believe to be ambergris. Says the bulletin in part: "True ambergris . . . usually has the consistency of wax or pitch, but may be almost brittle . . . Ambergris will not dissolve in water, but floats even in fresh water, having a specific gravity between 0.78 and 0.98. It melts in hot (145-150°F) water well below the boiling point.

"The simple hot wire or needle test for true ambergris requires no special

SO MANY THINGS TOSSED UP *by the sea resemble ambergris, is is best to test a fragment of your find before going to the trouble and expense of shipping it to a laboratory. A simple method, the hot wire or needle test, requires no special apparatus. Heat a piece of wire or a needle in a gas or candle flame for about 15 seconds, and then press it into the sample to a depth of ⅛ of an inch. If it's genuine ambergris, a dark brown to black, opaque, resinous liquid will form around the wire and appear to boil. (Walter R. Courtenay)*

apparatus. Heat a piece of wire or a needle in a gas or candle flame for about 15 seconds and then press it into the sample to a depth of one-eighth of an inch. If it is genuine ambergris, a dark brown to black, opaque, resinous liquid will form around the wire and appear to boil. (If the sample is wax, the liquid will be clear). Then withdraw the wire and, before the melted material on the wire cools, touch it with your finger. True ambergris will leave tacky, pitch-like "strings" sticking to the skin. (Most waxy substances so treated either cleanly coat the fingertip or merely take its impression.) When cold, the string of melted ambergris is shiny and resembles dark brown or black enamel.

"When the wire, which retains portions of the melted material, is again placed in the flame, true ambergris will soon emit a white fume having

the same characteristic odor as the solid, and then burn with a luminous flame. (Waxes do not emit fumes until almost ready to ignite, and the fume has a typical "hot wax" or acrid odor.) Note the odor of the smoke when the flame is extinguished. It should have the odor of burning rubber.

"One quick test is to dissolve a little piece in a small quantity of hot wood alcohol (methyl alcohol), then allow it to cool. True ambergris will crystalize as the alcohol cools."

Please Query First

Unfortunately many beachcombers send their finds to the Laboratory before writing to us, so we have no chance to send them the Bulletin. This material lands on the desk of Sigmund Miller, one of our chemists, usually to the detriment of his morale — especially that part associated with his olfactory apparatus!

A glance eliminates the great majority of materials. One of the most recent samples was a small bottle of what at first appeared to be a watery liquid. On closer look a small, very dead jellyfish could be seen. More commonly the samples consist of materials a good deal closer to the actual form of ambergris. Candle wax and pieces of rubber are common, carnauba wax, (a yellowish product of South American palms, used in polishes) is frequently encountered.

So the usual phrase in our letters of reply to hopeful people, like the lady mentioned in the opening paragraph, is ". . . we are sorry to tell you that your material is not ambergris."

Still, this strange, amorphous substance does exist, and who knows— someday you may beat the odds and actually find a piece of that marvellous product of whale's bowels and send it on the first leg of its journey to a fashionable lady's perfume!

"*Artificial Reefs*"

It is established fact that most fishes do not like open water or sandy shoals because there is no place to hide if pursued by larger fishes. This accounts, in part, for the large fish populations found around reefs or sunken wrecks. Now comes the "artificial reef," which, according to the Bulletin of the Sport Fishing Institute, had its inception about three years ago in Alabama.

Old automobile bodies were dumped into sandy bottom areas of the Gulf of Mexico, eight miles offshore and in water 60 feet deep. Soon snappers moved in, and then groupers, jewfish, triggerfish, king mackerel, dolphin and other species. The project was carried out by the Orange Beach Deep-Sea Fishing Association, with the approval and encouragement of the Alabama Department of Conservation. The idea is catching on along seacoasts all over the country.

DERELICT U. S. TUNA SHIP, *washed ashore in Peru during a storm. Most extreme of all claims to territorial waters are those of Chile, Ecuador and Peru, who assert complete ownership over the sea (and its products) from their shorelines out to 200 miles, or to the limits of the continental shelf, whichever is greater. The territorial dispute and present definition of world-wide fishing and other maritime rights will be on the agenda of the Gulf and Caribbean Fisheries Institute meeting, November 17 to 21, at Miami Beach. (Marine Laboratory)*

Gulf and Caribbean Fisheries Institute and Game Fish Conference

THE ELEVENTH ANNUAL MEETING of the Gulf and Caribbean Fisheries Institute, November 17 to 21, at Miami Beach, Florida, promises to provide the same timely, high-standard papers and provocative discussions that have characterized these sessions in years past. For example, electrical fishing in the sea, a topic discussed in a recent issue of *Sea Frontiers,* will be described by the man who knows most about it in the world—Conradin H. Kreutzer. Dr. Kreutzer has spent the past five years perfecting a method of using electricity to help catch menhaden, and his paper should point the way to future developments.

A second matter of enormous current interest, and again one covered in *Sea Frontiers* in recent months, is that of the territorial waters dispute, such as Iceland's recent "cod fish war," and the definition of world-wide fishing and other maritime rights. The latest developments in this touchy problem will be described by William Neblett, one of the advisors to the American delegation to the Geneva Conference on the Law of the Sea held this spring. Mr. Neblett will treat the subject especially in relation to

the shrimp industry.

The manner and degree of concentration of radioactive materials is of vital importance to the well-being—even the survival—of the human race. How this is done by marine organisms will be described by Dr. Walter Chipman of the Fish and Wildlife Service. With atomic plants — military and otherwise—throwing increasing quantities of radioactive material into the sea this subject becomes one of mounting importance.

Latest in Sports Fishing

Another outstanding paper scheduled at the Institute meeting is by Daniel Janzen, Director of the Bureau of Sport Fish and Wildlife of the Fish and Wildlife Service. This Bureau, set up only two years ago to handle research and development of sport fishing and wildlife arrangement, is rapidly developing a valuable program, which Mr. Janzen will reveal.

Each of the five days of the meeting features a different general topic. On Monday shrimp papers will be presented, on Tuesday, papers on menhaden and other industrial fishes. The problems of merchandising fish will be attacked on Wednesday while biological papers are scheduled for Thursday. The last session stresses fisheries work in the Caribbean.

The meeting will be held in the Barcelona, a new ocean front hotel in the 4300 block of Collins Avenue, Miami Beach. The Gulf and Caribbean Fisheries Institute is unique in having no formal membership, welcoming anyone to its sessions who has an interest in fish or fisheries. Registration forms will be sent to anyone wishing to attend the meeting. Enquiries should be directed to:

The Executive Secretary
Gulf and Caribbean Fisheries Institute
The Marine Laboratory
#1 Rickenbacker Causeway
Miami 49, Florida

Third International Game Fish Conference

World-wide problems related to ocean game fish will be discussed during the third annual meeting of anglers, guides and biologists, at the Barcelona Hotel, Miami Beach, Wednesday, November 19, 1958.

A morning slate of papers is planned, with discussions to be held in the afternoon. Among the speakers and topics for this year's conference are: Don McCarthy, surveying the sports fishing potential of the Bahamas; Frank Mather, reporting on recent studies of amberjacks; John Randall, describing last summer's tarpon investigations; and Col. John K. Howard, discussing game fishing on the East African coast.

No formal membership is required for this conference, which is sponsored by The International Oceanographic Foundation, and anyone interested in saltwater game fish, whether from angling, charter boat or scientific aspects, is cordially invited to attend. The afternoon session is not limited to the subjects of the morning papers. Any topic or question may be raised from the floor.

ONE MOMENT FROM DEATH! *Arrow (lower left) points to a man trapped in the path of the surging waters that suddenly and without warning crashed upon the busy waterfront of Hilo, Hawaii. He was one of the 159 victims of the devastating tidal wave or tsunami of April 1, 1946. In addition, 163 persons were hospitalized, countless others suffered minor injuries, and property damage was estimated at $25,000,000. (U. S. Army)*

Most Ominous Wave!

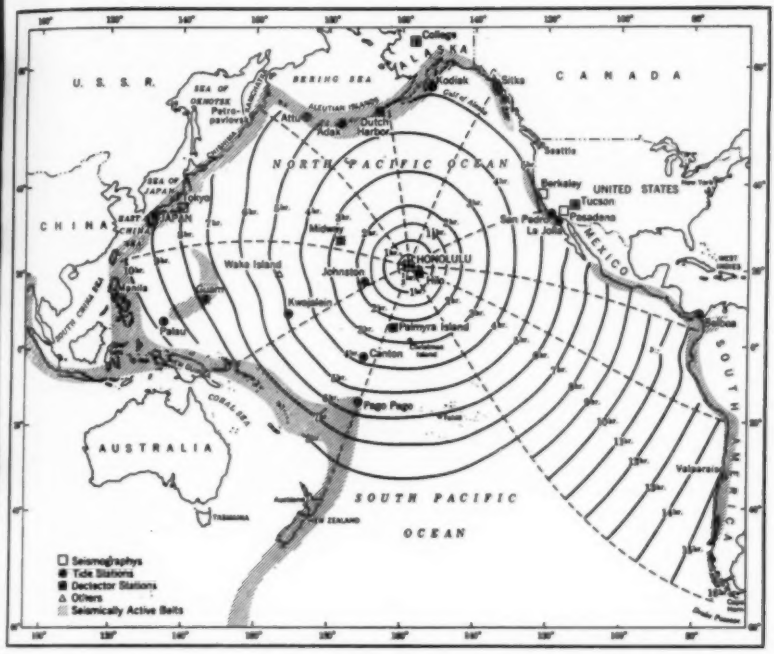
By E. JOHN LONG

WHEN WE CONSIDER speed in nature we generally think of light, which travels at 186,000 miles per second, or sound, which, in water, zips along at nearly a mile a second, or, in air, at 750 miles per hour.

Down the scale a bit are the outer winds of a hurricane, which have been clocked at 200 miles per hour before the instruments blew away. Living creatures, too, can move right along short distances or spurts. The duck hawk, for example, reputedly can fly 170 miles per hour; the cheetah has attained 70 miles per hour; porpoises have kept pace with boats going 30 miles an hour; and such fishes as the dolphin and the tuna, based on runouts of fishing line after a strike, have reached an estimated 25 miles per hour or better.

Real Name Is "Tsunami"

In any such popular listings, however, almost never do we find one of the fleetest things on earth—the tidal wave. Yet it has been accurately paced over vast distances at speeds ranging from 150 to more than 500 miles per hour. This odd oceanic phenomenon, with crests nearly 100 miles apart, can pass harmlessly and



SEISMIC SEA WAVE WARNING SYSTEM. *The shaded areas indicate the regions where tidal waves, or tsunamis, are most likely to originate, and the curved lines are the estimated seismic sea wave travel times to Honolulu, Hawaii. The time required for a seismic sea wave to reach Honolulu can be obtained by plotting the location of the epicenter (origin) on the chart, and noting its position with respect to the time curves. The map also shows the locations of tide stations, detector stations, and other tsunami "listening posts." (U. S. Coast and Geodetic Survey)*

unnoticed under a ship at sea, and then, not too far away, may wreak havoc on islands or mainland waterfronts in its path. Remnants of the surges of one immense tidal wave traveled a distance equal to half the circumference of the earth, in less than one and a half days!

Although the term "tidal wave" has become so firmly established in the English language that popular usage will probably attach it to every type of destructive wave, scientists have a better term for the bigger, more vicious ones—tsunami, from the Japanese tunami meaning "cove or harbor wave." Actually, such huge impulses, which follow submarine earthquakes, volcanic explosions at sea, and massive underwater slides, have nothing to do with daily tides at all, and they bear little outward resemblance to other waves until, king-size, they crash upon an unsuspecting shoreline.

Of Rare Occurrence

Fortunately, these mad monsters from the ocean depths are of comparatively rare occurrence. Although

WITH RELENTLESS FURY, *the seismic sea wave of April 1, 1946 breaks over Pier No. 1, Hilo, Hawaii. Only moments before, a great extent of the harbor had been left dry, and hundreds of people rushed down to witness the novelty. Suddenly they were caught by a wall of water, rising 20 feet above the high-water mark drowning many of them, and destroying everything in its path. (U. S. Army)*

a tsunami could originate in any of the world's seas, most of them have sprung from two regions—the northern and western Pacific, and the northern Atlantic. The seacoasts of Japan and Hawaii have been the chief victims of their attacks, and the area just south of the Aleutian islands the most prolific single birthplace.

The Greeks knew tidal waves of the type we now call tsunamis, and it is possible that some of the great seacoast disasters of ancient times can be attributed to them. It is also interesting to speculate that the mythical Atlantis, Plato's lost continent, might possibly have exploded in a terrific holocaust to create the greatest tsunami of the past.

The most damaging Atlantic tsunami of which there are accurate records occurred off Portugal in 1755, pounding the coast with waves 50 feet high, and sending smaller surges to the West Indies, England, and the shores of North America.

When Krakatao Blew Up!

Most disastrous of tsunamis in modern times took place in 1883, when the volcano of Krakatao, between the islands of Java and Sumatra, blew up, sending out gigantic waves that swept away 1,000 villages on nearby islands and took a toll of 36,000 lives. Almost equally destructive was the tsunami that roared into the Sanriku district of Japan, in 1896, destroying 13,000 houses and killing 27,122 persons.

Hawaii's most staggering blow came on April 1, 1946. This unheralded "April Fooler" began at 2

a.m., in far-off Alaska, when a subterranean earthquake jolted the ocean floor near the Aleutians. It sent a huge tsunami toward the Aleutians and other impulses southward at jet plane speed. By 6:19 a.m., four and a quarter hours later, the first big wave had broken over the north coast of Kauai, and in less than an hour had swept around all the Hawaiian islands. Wave followed wave in the most devastating series of oceanic attacks the Territory has ever known. When the seas finally subsided, at the end of the day, 159 persons were dead, 163 hospitalized, and estimated damage totalled $25,000,000.

Best-observed Tsunami

Because a number of prominent scientists were in Hawaii at the time, this was probably the best-observed tsunami of all time. Seismographs finally located the origin of the giant waves in an earthquake, far below the surface of the Pacific, off the Aleutian island of Unimak. The quake probably deepened the floor of the fault trough in this area, and water rushing in from both sides met —wham!— in the center. Rebounding, they set the first wave on its course.

Giant oscillations, soon set up deep in the ocean, pushed out wave after wave at regular intervals. As the trough ran in an east-west direction, the waves moved with greatest strength to the north and to the south.

Less than five hours later, the first

RESCUE WORKERS *comb the tangled debris that once was the business district of Hilo, Hawaii's second largest city, searching for the injured and the dead. The tsunami of April 1, 1946, left a nightmare of wreckage and a host of problems involving sanitation, power, food, and medical supplies. An ingenious warning system now gives Hawaii's residents sufficient notice to flee from waterfront areas. (U. S. Army)*

STEEL RAILROAD TRACKS *were twisted and tossed aside as giant waves raced inland during the tsunami of April 1, 1946. The rails in the foreground held because they were on a bridge that allowed the raging flood waters to pass beneath. The photograph was taken near Sunset Beach, on the island of Oahu, Hawaii. (U. S. Army)*

wave had sped 2,300 miles to Hawaii, at an average speed of 470 miles per hour. There was not then (as there is now) any advance warning system, but fortunately the first three waves, at intervals of about 12 minutes, showed a progressive increase in height, giving many shore dwellers an inkling of what was to come and a chance to run for their lives.

When The Surf Ceased—Silence!

Another important observation made by scientists and others in 1946 was a sudden withdrawal of water from the reefs and flats offshore, preceding the arrival of the most disastrous waves. This lull before the storm was immediately noticeable, because it silenced the usual uproar from the surf.

At first it was believed that the water withdrawal *preceded* the arrival of the first tsunami. Later, scientists advanced the theory that this was the

trough which *followed* the first wave, the latter not being large enough to attract attention. This is borne out by reading of Hawaiian tide gauges on the far, or south, side of the islands. These showed progressive increases from a weak first wave to a strong fourth, on one gauge, and from the first to the sixth, on another.

Lighthouse Snuffed Out

Witnesses noted, too, that unlike normal wind or storm waves, tsunami waves can appear out of a clear sky, hurdling reefs and other obstacles, and can continue inland for considerable distances. At Hilo, on the Island of Hawaii, they crashed ashore 30 feet or more high, wiping out much of the waterfront.

Even so, Hawaii did not experience the biggest waves resulting from the 1946 quake. At Dutch Gap, in the Aleutians, a lighthouse perched 100 feet above the sea was destroyed by mammoth combers. Only the fact that very few people live along the shorelines of the Aleutians prevented a large loss of life there.

100 Miles From Crest to Crest

Perhaps the strangest thing about the phenomenon is that ships at sea are not able to flash any advance warning of tsunamis, even when the waves race by them at full speed. Until they near shore, or a submarine obstruction, tsunamis are the *longest* of waves, stretching as much as 90 to 100 miles from crest to crest. Consequently in the open ocean they have a total height of only one or two feet, or not as much as the waves raised by fair-weather winds.

How far can tsunamis travel? In the case of the April, 1946, tsunami, the California coast experienced waves ten feet higher than normal, causing some damage at Half Moon Bay. Yet gauges in lower Alaska and British Columbia did not register as large waves as did gauges in South America, indicating that the 1946 tsunami had a *line* source rather than a *point* source.

Reach English Channel!

The real long distance champion tsunami followed the eruption of a volcano in Sunda Strait, between Java and Sumatra, in 1883. When Krakatao blew its top in a series of mammoth explosions, August 26-27, waves did not enter the Pacific, but they quickly crossed the Indian Ocean and could be traced up through the Atlantic, finally reaching the English Channel, where they were recorded within 32½ hours of the initial eruption. This is a distance of nearly half the circumference of the earth!

Another frequently asked question about tsunamis—how can they move so fast? The simplest answer is that water, unlike air and gases, is almost incapable of being compressed. When water is struck by sudden, titanic forces, it cannot give, but only transmits its quickly acquired energy in a series of thrusts. These may race along for thousands of miles at a fairly uniform rate of speed, the latter depending upon the initial strength of the wave, and the nature of the bottom.

Like Hitting a Rock

Oceanographers now list two different types of seismic sea waves. Sometimes a submarine earthquake

will produce only longitudinal oscillations or vibrations. These may flash straight up from the bottom at the speed of sound waves. If a ship should be passing directly over the area, the shock can be so severe as to toss it violently, and those on board will swear they have struck a rock.

In fact, "rocks" or "reefs" shown on ancient charts, where only deep water is known to exist today, can probably be attributed to such seismic disturbances, or can possibly account for the mysterious disappearance of a few ships in areas subject to submarine earthquakes.

If gases or volcanic matter accompany the vibrations, a transverse wave may be set up that spreads out like ripples in a pond. Except close at hand, however, this type of seismic disturbance is not very destructive.

No Lives Lost in 1952 Tsunami

Since the devastating tsunami of 1946 in Hawaii, a vast land and sea warning system has been set up that has proved most effective. Thanks to this network, and the cooperative efforts of several government agencies, no lives were lost when another large seismic sea wave attack hit Hawaii in November 4, 1952. With several hours leeway, residents could move vehicles, cattle, and other mobile possessions, so the damage toll was also much lighter. Ships could be sent well out to sea, where they had no difficulty in riding out the waves.

What are the elements of this warning system? Like the hurricane-spotting network of the Gulf and Caribbean areas, it covers a great deal of geography, and it also involves the work of much technical equipment as well as the rapid functioning of many skilled technicians and scientists.

Centers At Honolulu

The principal activities that have united in this pin-pointing and course-predicting of seismic sea waves are: (1) Seismograph stations, (2) Tide or wave reporting stations, and (3) the communication services of the Navy, Army, Air Force, Civil Aeronautics Administration, and others that link the above stations with the Hawaiian Islands. The Honolulu Magnetic Observatory of the Coast and Geodetic Survey serves as the focal center of the system.

First to realize that an underseas earthquake has occurred, and to collect quickly the seismological data required to indicate its size and epicenter, are the seismograph stations. There are a dozen or more of these, located in such widely-scattered places as Adak, Sitka, and Fairbanks, Alaska; Berkeley and Pasadena, Calif.; Tucson, Arizona; Tokyo, Japan; Huancayo, Peru; and in many of the Pacific islands.

Automatic Watchdogs

Because years may pass without a dangerous tsunami, it is impractical that all these stations be kept on a continuous manned alert. So some of them have instruments especially devised to set up an automatic alarm when there is a large quake. Observers then flash readings to Honolulu on their own initiative, or on the request of Honolulu.

Meanwhile, tide stations go into action. The automatic tide gauge re-

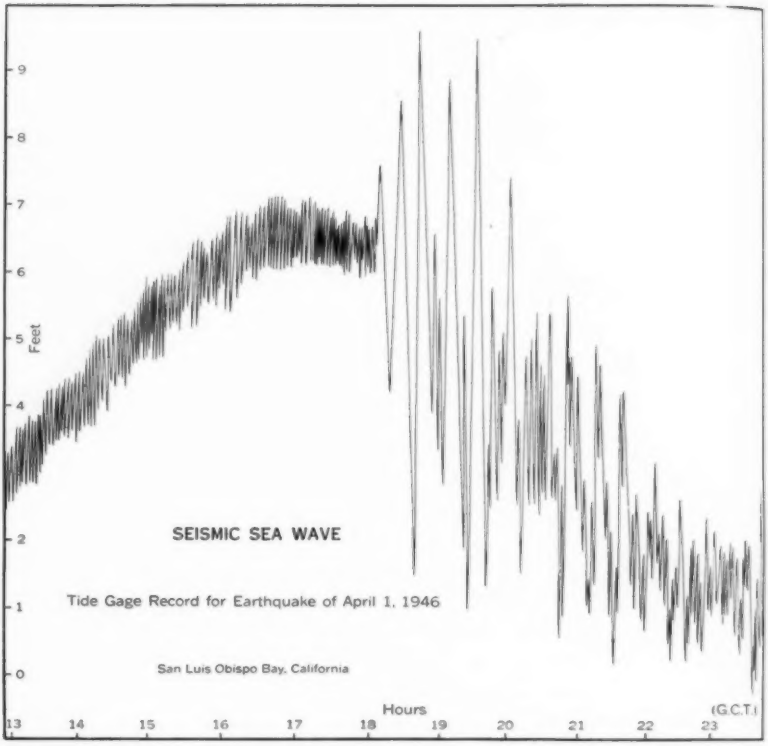
EVEN SOLID CONCRETE WAS BROKEN UP *by the pounding of the hard-hitting waves that accompanied the tsunami of April 1, 1946. This washout of the Territorial Highway took place near Kaawa, Oahu, Hawaii. At no time was any earthquake shock felt in the Islands, either immediately before, during, or after the most destructive seismic wave attack in Hawaii's history. (U. S. Army)*

cord is an excellent means of revealing the existence of a big wave and for providing accurate information. The system is a little larger and even more widespread than is the seismograph station network, including about sixteen stations, located in Alaska, California, the Canal Zone and the Pacific islands, as far south as Samoa and as far west as Guam.

At a few of the tide stations, seismic sea wave detectors have been added as a local precaution against delay in receiving an alert from Honolulu. This device alerts the tide observer of the arrival of large waves having the period of seismic sea waves, and the observer can then examine his tide record and, if necessary, initiate a warning message to Honolulu.

Inter-Island Warnings

Seismic sea waves, as has been pointed out, travel with such terrific speed that the amount of time available for obtaining wave direction reports is very limited. The amount of usable time, of course, will depend upon the location of the earthquake. Such information may be even more important to low-lying Pacific islands than to more heavily populated, but more hilly, Hawaii.

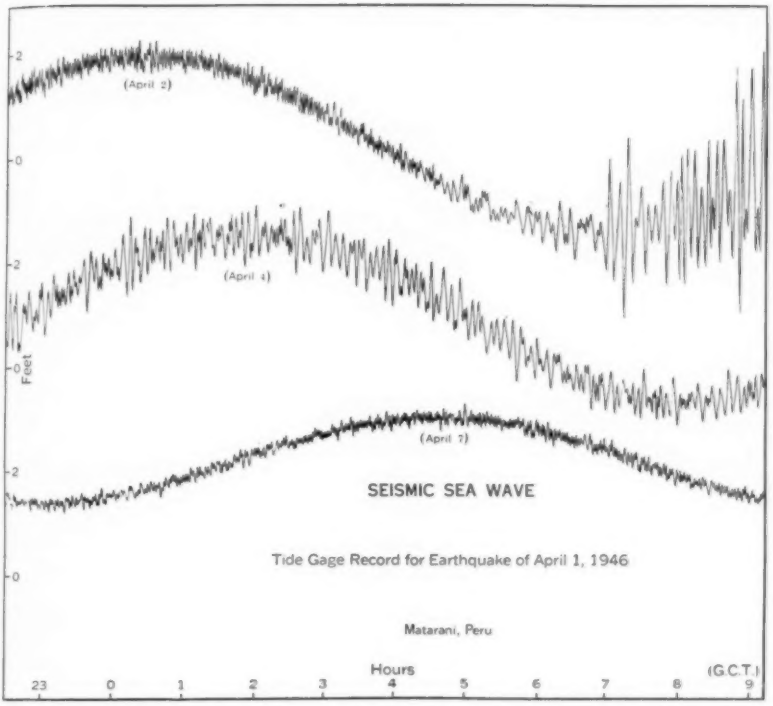


THIS GRAPHIC PICTURE OF THE SEAQUAKE *of April 1, 1946, was recorded on the tide gauge at San Luis Obispo, California. The oscillations (left), occurring before the arrival of the seismic wave, have a period of about four minutes and a height of one foot. They are, of course, of local character. Then came the initial shock, followed by others until the gauge registered a maximum range of 8½ feet! (U.S. Coast and Geodetic Survey)*

Consequently, exchange of any information of a "suspicious nature" is given every priority, although Honolulu is still the best source of reliable data as to the intensity and probable direction of any waves likely to hit Hawaii or any place in the Pacific area.

Rehearsing "The Word"

All the data in the world would be useless without fast communications between seismological and tide stations, and Honolulu. The military services and CAA give any message related to seismic sea waves top handling. In fact, because tsunamis come so few and far apart, they even stage rehearsals or tests of such "flashes" at unannounced times once a month. For identification, each "live" message begins with "seismo," and each test with the words "seismo dummy."



EVEN IN FAR-OFF PERU *the tide gauge recorded the Aleutian seaquake of April 1, 1946, although the seismic wave did not arrive at Matarani until April 2, some 24 hours after the initial shock. The upper tide curve is for eleven hours on April 2, and the second curve is for the same hours on April 4, with the seismic wave still in evidence. By April 7, Peruvian waters had returned to normal. (U. S. Coast & Geodetic Survey)*

How the System Works

Whenever there is a large underseas earthquake in the north Pacific area, where most of the world's seismic waves originate, the sequence of events is usually as follows:

(1) The Honolulu Magnetic Observatory, as the focal center of operations of the system, obtains and evaluates seismograph reports and locates the earthquake epicenter, usually within an hour and a half.

(2) If it is at a place where it could not cause a sea wave in the Pacific, nothing further is done.

(3) If it is where it could cause a wave, the center calls upon selected tide stations to watch their gauges, usually specifying a period of an hour or two, and to report back.

Charts Prepared in Advance

Special charts, which have been prepared in advance, show when a resulting wave should reach Honolulu

AFTERMATH OF THE SEISMIC WAVE *onslaught of April 1, 1946, along the waterfront of Hilo, island of Hawaii, Hawaii. Although the storage shed of Territorial Pier No. 2 is almost a total wreck, an American freighter has managed to tie up to the undermined quay and is unloading food and other supplies needed by the stricken survivors. It was many months before conditions returned to normal in Hawaii's second biggest port and city. (U. S. Army)*

and the tide stations, so that the center knows how much time can be used in obtaining reports.

(4) If the tide stations report a major-sized wave, the center at Honolulu notifies certain designated civil and military agencies, and these then put into action their previously made plans for warning the civil population, shipping and military bases, so that shore areas may be evacuated, and other steps taken.

The Coast and Geodetic Survey, U. S. Department of Commerce, recently completed arrangements to give warnings also to civil defense authorities along the Pacific coast. New charts, showing the travel time for earthquake sea waves, originating on the northern rim of the Pacific Ocean, chiefly in the area of the Aleutian Islands, have been finished.

Will Notify State Civil Defense

The charts have been drawn to give the time required for seismic sea waves from various points along the northern rim of the Pacific to reach

(1) Neah Bay, Washington, at the entrance to Puget Sound; (2) Crescent City, California; (3) San Francisco, (Golden Gate), (4) San Pedro, harbor of Los Angeles; and (5) La Jolla, California.

The Coast and Geodetic Survey will also notify state civil defense offices in Olympia, Salem, and Sacramento that seismic wave estimated-arrival-times are being prepared and will be dispatched to them from Honolulu at the same time information affecting Hawaii is issued locally.

In the opinion of Survey experts, the Northern Pacific Ocean area is the only source of potentially damaging seismic sea waves to the United States, with the possible exception of the ocean bottom off the Pacific coast. A warning system, however, could not be effective for any waves of such close origin, because they would arrive in matter of minutes.

Keeping the Octopus Cool

YOU WOULD NOT THINK that sea water as far north as Vancouver, B.C., would become too warm for aquarium tanks. Yet during bright sunny days of May the temperature of Burrard Inlet, off the Vancouver Public Aquarium, rises quite a bit. At the same time, very low tides in the middle of each day make it difficult to pump a steady flow of water into the Aquarium.

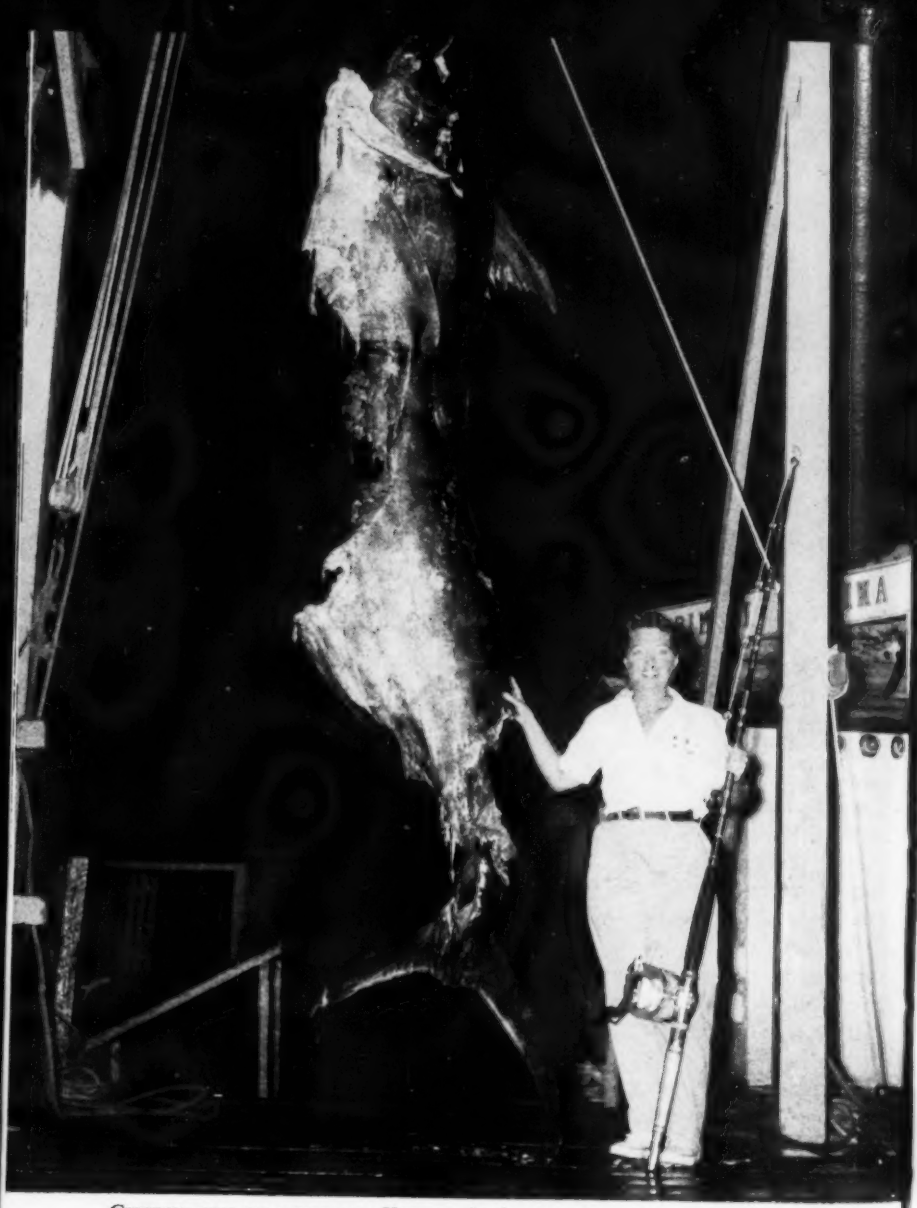
As a result, temperatures in the tanks formerly rose to the high 50's. This would still be quite chilly for sea life in Florida or Honolulu, but up Vancouver way such temperatures gave the local fishes and marine invertebrates the equivalent of sweaty brows.

One of the chief sufferers was the Aquarium's largest octopus. This beast lost its dark red color and moped about his tank like a dirty gray ghost. To show his distress he sloughed off the round outer margins of his suckers, making the water of his tank appear very dirty.

Engineers of the Fisheries Research Board's Technological Station finally came to the rescue by constructing an ingenious heat exchanger which required only a one-horsepower, electrically-driven refrigerator compressor. It consisted of a series of stainless-steel pipes, each of which is in a larger copper pipe, which in turn is insulated by a thick layer of fiberglass.

The liquid refrigerant flows in the space between the two pipes, thus cooling a flow of sea water inside the stainless-steel pipe. The engineers ran into only one real problem in designing. Since copper and stainless steel have different rates of expansion and contraction, the two types of pipes could not be welded, but had to be joined by a special accordion-like device which yielded but nevertheless did not leak.

The unit worked so well that two tanks are now being refrigerated by it. The octopus now appears content at a pleasant 53 degrees.



CHEWED OUT OF A RECORD. *Hungry sharks were the victors when Mrs. Dorothea Dean, of Palm Beach, landed this 13-foot blue marlin off Bimini, Bahamas. It weighed, even in its abbreviated condition, 568 pounds, only a few pounds less than the women's world record. Sharks are considered by anglers the "most useless" of fish, but they nevertheless have useful hides, flesh and liver. (Bahama News Bureau)*

Sharks Are Useful

By ALFRED VOLPE

The Marine Laboratory, University of Miami

MANY AN ANGLER who has lost a prized catch to a shark, or a commercial fisherman who has had hundreds of dollars worth of nets torn to shreds by one of these voracious beasts of the sea, would like to see their numbers drastically reduced. But is it worth while fishing for them? What is their value commercially?

Practically every part of a shark has its uses. For instance, the liver is often rich in vitamin A. White meat of most species, fresh or salted, is a wholesome human food. The hide produces a good leather, and the remainder of the fish can be converted into animal feed and fertilizer.

However, shark fishing in the United States has been a minor industry, except between the years 1939 and 1950. At that time we were interested only in the livers, and usually threw the carcasses back into the sea, as it was unprofitable to process them. Perhaps the day will come when we shall need to fish for sharks more intensively, so let us take a look at today's shark fishery, and its products.

$50 Bills from the Sea!

The outbreak of World War II in 1939 curtailed cod liver oil production in Europe. However, the local, almost untouched shark population represented a tremendous source of liver oil, and before long we were not only meeting the American demand but were also supplying Europe with this commodity. As its high vitamin potency became known to the trade, the great vitamin fad of the 1940's was stimulated. Through skillful advertising and aggressive promotion vitamins developed into a billion dollar industry. At one time every soupfin shark caught was the equivalent of hauling a fifty dollar bill out of the water.

The average liver of the soupfin shark weighs about 5½ pounds and yields from 60 to 70% oil containing 86,000 units of vitamin A per gram of oil in the males and 43,700 units in the females. This vitamin A content varies in different sharks depending upon the species, sex, feeding habits, and the time of the year. For instance, the livers of the great hammerhead, and some of the ridgeback sharks of the genus *Eulamia* have a high vitamin A potency, while lemon and tiger shark livers yield only a fair amount of vitamin A and D.

The yield from the nurse and bull sharks, on the other hand, is low. The small dogfish does not have as great a vitamin A content as the soupfin; still its relative abundance and numbers of species make up in quantity what it lacks in quality.

End of the Boom

Livers high in vitamin A reached a peak value of $18.00 per pound. Then, just when the shark fishermen thought they had a short cut to wealth, vitamin A was synthesized, and by early 1950 sharks were once

again free to roam the seas off the United States with little fear of capture.

The huge basking shark *Catorhinus maximus* was not so lucky, for the mere magnitude of the products obtained from this huge fish makes it economically feasible for a few fishermen to catch him. This shark is a large inoffensive creature which feeds on small planktonic animals. Some reach a length of 45 feet, and have livers weighing as much as 2,100 pounds. While the great mass of liver yields from 60 to 70% oil, it contains little or no vitamin A, and is used mostly by the tanning industry for currying leather. It has been occasionally utilized in the manufacture of low grade soaps, tarpaulins and

STRONG GEAR IS NEEDED *to catch sharks. Commercial shark fishermen attach baited hooks on chains to a cable that stretches out for 500 yards or more. The cable is held between two buoys, and the lines are left for 24 hours. (The Borden Company)*

oil cloths, in tempering steel, and has also been blended with other oils for production of medicinal oils.

Fillet of Sole—Shark Style

Most sharkflesh, if properly handled, can be marketed either fresh or salted, and made into tasty and wholesome food. However a prejudice has been built up against shark flesh due to ignorance, for many people believe that sharks eat human beings. There would be few sharks in the waters if they depended upon people for food. Conversely, people have eaten sharks unknowingly under such names as: "Fillet of Sole," "Tenderloin of Sole," "Grayfish," "Cuban Cod," "Victory Cod," and even "Sturgeon."

In England, shark flesh finds a ready market as "fish and chips." During the shark liver oil boom, flesh of the soupfin shark had a ready sale in Los Angeles because of its low price and good flavor. The small (7-10 lb.) dogfish *Squalus acanthias* has long been used as food in Scotland. Some people claim it tastes like halibut. Others say it is somewhat mealy and like cotton in texture. The eggs of this shark contain several times more yolk content than that of a chicken and has been used in puddings in Norway as a substitute for hen's eggs.

Warning—It Spoils Quickly!

Among the sharks eaten in various parts of the world are the nurse shark, tiger, lemon, great hammerhead, thresher, mako, great white shark, ridge-back sharks, and the bull shark, whose white meat resembles swordfish in flavor.

Shark meat has its deficiencies. It "goes off" or spoils more quickly than fish flesh, and should never be eaten unless the shark is absolutely fresh. Most shark meat does have a characteristic smell and tends to leave a dry taste on the tongue, but with proper preparation these two objections can be removed.

Non-Slip Sword Handles

Shark skins have always had value, for the finished leather made from certain species is extremely tough, resistant to abrasion, yet pliable. The skin with the shagreen (calcarous coating) intact has found uses in the past as a nonslippery surface for the handles of sword hilts (this market has not been very active of late), and it was also used in cabinet work as a fine abrasive agent before the invention of sandpaper.

Very few shark skins are produced in the U. S. Difficulties involved in skinning and preserving a shark hide to meet market requirements involve so much time consuming labor that most American fishermen are not interested. One fisherman from southern California divised a method which he claims works very well. The shark is hung from a boom, a small incision is made near the tail, and a flattened piece of copper tubing, to which a high pressure air hose is at-

ONE OF THE UGLIEST CREATURES *of the sea is the hammerhead shark, whose eyes are located at the outer ends of his hammer-like head. While fierce and powerful, it dies quickly when its free movements are restrained. It usually will expire within an hour if entangled in even a light net. (The Borden Company)*

tached, is inserted. By gradually increasing the air pressure the skin is forced away from the body, thus eliminating the tedious fleshing operation.

Best Hide on Nurse Shark

The nurse shark found throughout the tropical Atlantic has the best hide of all American sharks, and is the only one on which a premium is paid. The tiger shark, one of the most numerous of the larger sharks of the West Indies, has a hide that has six to ten times the tensile strength of ox hide.

A bowl of shark fin soup is worth the fiercest battle that any shark can put up. It is easy to understand why the fins find a ready market in the oriental trade. They command their highest prices when they are taken in complete sets, and for species having valuable fins, it is important to include the lower tail fin. Practically

all shark fins have value except those of the nurse shark, and the side fins of the sawfish shark. To prepare them for market, one merely cuts them from the shark, salts the cut portion, and dries it in the sun.

Fertilizer and Curios

Fish meal, an extremely valuable source of protein for feeding stock, may be made by boiling fresh scrap meat, offal and bones to rid them of oil. This scrap is then pressed, dried and ground into a coarse meal. Scrap material can be processed in the same way and used for fertilizer.

The last part of the shark to be utilized are his teeth, jaws, and backbone. Good-sized teeth, jaws and backbones, either merely cleaned, or made into novelty items, have always been in demand by tourists.

How to Catch a Shark

There are four principal methods by which sharks may be caught: Hook and line, nets, trawls, and harpooning. The hook and line method can be as simple as a single hand line of at least 72 thread, with six to eight feet of 1/16th to 1/8th inch stranded wire cable as a leader, and a shark hook anywhere from two to four inches across the jaw. Or it can be the more elaborate chain set line, which is a system of multiple hook set lines spaced at 30 foot intervals along a 600 foot chain. This chain is usually anchored at either end and suspended various depths by means of floats. The depths are dependent upon the habits of each species.

CHAINED FURY LASHES THE SEA. *This is no time to slack the line or to risk an arm or leg near those ferocious jaws. While some persons say sharks will not attack humans, commercial fishermen have brought in specimens containing parts of human bodies, as well as watches and jewelry. Sharks hunt by their sense of smell, and since most sharks are particularly attracted by blood, chumming with blood will usually bring sharks to the hook. (Marine Studios)*

In general, sharks are bottom feeding fish. An oily fish is a good bait to use preferably if it is a bit "high," or spoiled. Porpoise meat is said to be very effective, as well as mullet, bonita, and small tuna. Since sharks hunt their food by sense of smell, and most are particularly attracted by blood, chumming with blood will often bring sharks to the hook.

Entangling in Nets

A large mesh, loosely-hung gill net is most successful for big scale operations. The sharks are not necessarily gilled, although they can be, but most are caught by entangling themselves in the net after they have hit it. When attempting to turn, the shark rolls and in so doing wraps the slack web around itself, so that

HOW NET FISHERMEN HATE SHARKS! *Webbing that is strong enough for small fishes is ripped to pieces by the big predators. Sometimes a shark, entangled in a net, will roll in an attempt to free himself, tearing the net from its moorings and making off with it. (The Borden Company)*

it is tightly bound on all sides. The fierce, powerful great hammerhead dies quickly when its free movements are restrained. It usually will die within an hour if entangled in even a light net.

The small dogfish are usually captured by trawls while trawling for other species. Occasionally larger species, such as the sawfish, are captured in this manner.

Harpooning is the fourth method and is used almost exclusively on the large basking shark. At Pismo Beach, California, a unique team consisting of a light airplane and a surplus army DUKW (an amphibious vehicle) fish for these sharks. The plane spots the shark from the air and radios its position to the DUKW, which drives along the beach until it is opposite the reported position, and then plunges into the ocean. The operator draws alongside the animal and harpoons it. The shark is then pulled into the vehicle and killed with a high powered rifle. Towed ashore, the carcass is pulled into a low-bed trailer truck and hauled to the processing plant.

Should I Fish for Sharks?

From time to time people inquire at The Miami Marine Laboratory as to the feasibility of going into the shark fishery. In order to make a profit, one must first be able to recognize the commercially valuable species. There are more than forty different species of sharks in the Caribbean area alone. If a catch includes too many of little or no value, one can go broke shark fishing.

Shark products spoil more easily than most animal products and they should be processed as soon as the shark is killed, for the livers start to deteriorate as soon as the shark is dead. Hides lose half their value if skinning is delayed as much as six hours in a warm climate, and flesh begins to spoil in a few hours. Often a fisherman is too tired to start preparing the products immediately, thus necessitating a separate labor force for this work. In most places sharks are rather seasonal, being common at some times and not at others. Different sharks have different seasons. For this reason one may find it possible to fish sharks profitably at only one time of the year and be obliged to combine this with other types of fishing.

At present the demand for shark products is small. Most fishing for sharks takes place along the coasts of the Caribbean islands, Mexico, and Central America, where labor is cheap.

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Satellites And Oceanography

OCEANOGRAPHERS also have an interest in the satellites hurtling across the skies. The man-made moons should enable marine scientists to determine more precisely not only the sea distances between continents but also the location of isolated oceanic islands, whose positions may now be in error as much as a mile.

Some scientists, according to the National Geographic Society, believe that continents drift, like enormous rafts, on plastic matter within the earth. Pinpointing the distance between continents should help to settle this question, also.

Oceanic Mapping Difficult

Why is the accurate mapping of sea areas more difficult than mapping land? Using trigonometry, a geodesist can map a country or even a continent with considerable accuracy by building up a network of triangles through painstaking surveying, then orienting the entire network to a single marker known as the geodetic datum point. For the United States, Mexico and Canada, this marker stands in a meadow near Lucas, Kansas.

LAUNCHING OF THE FIRST *successful U.S.-International Geophysical Year satellite, Cape Canaveral, Florida, January 31, 1958. Such man-made moons enable marine scientists to determine more precisely not only sea distances between continents but also the location of isolated oceanic islands, whose positions may now be in error as much as a mile. (U. S. Army)*

The triangulation method cannot be applied over the oceans due to the lack of fixed points. Therefore, it cannot link the continents. Satellites come to the rescue of the geodesist, because they can serve as fixed points even though they are traveling at about 18,000 miles an hour. Their orbits may be computed by ingenious electronic and visual means, and their positions determined at any given moment.

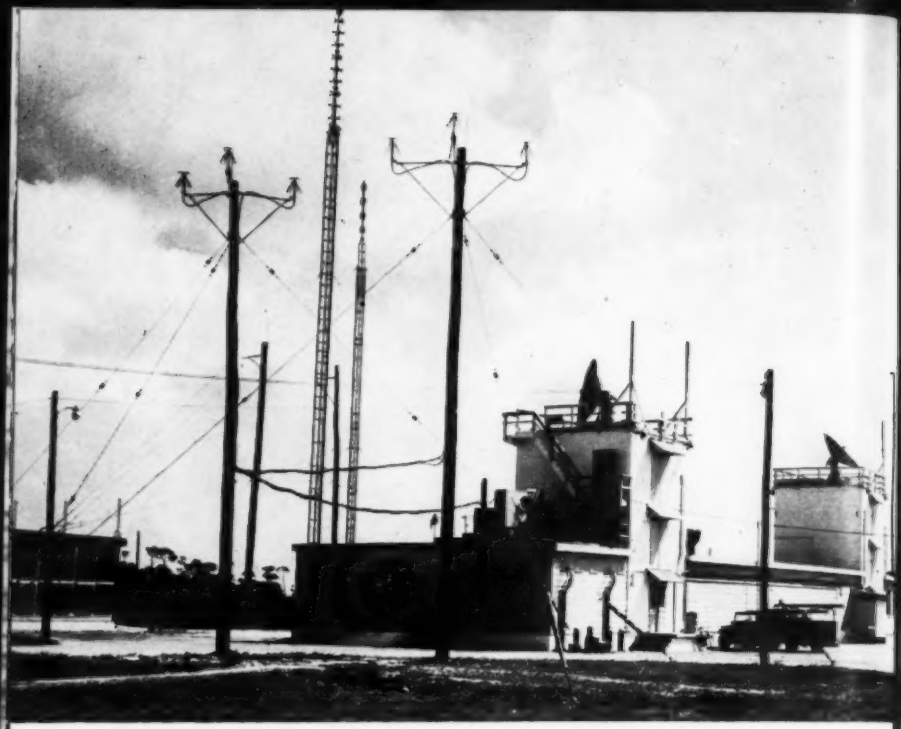
Accurate Within 50 Feet!

Using satellites as reference points, scientists hope to be able to determine the positions of points on earth in three dimensions—longitude, latitude, and distance from the center of the earth—to an accuracy within 50 feet!

This will not only help navigators and save oceanic surveying expenses, but should also enable scientists to plot the shape of the earth. Scientists know that the earth, far from being a perfect sphere, is flattened at the poles and bulges at the equator, so that its shape suggests an orange lightly pressed between the palms. But scientists do not know exactly how flat the earth is at the poles or how much it bulges at the equator.

Hills in the Ocean?

Results of the scientific measurements and calculations based on satellite data may not be available for some time to come, but they are eagerly awaited. Cartographers hope the information will make possible ever more precise maps for use by both scientists and laymen.



ONE OF THE SATELLITE "LISTENING POSTS," *Grand Bahama island, Bahamas. The sensitive ears of such stations pick up some of the data necessary to compute the orbits of the tiny moons, which geodesists use as fixed points, even though they are travelling at about 18,000 miles an hour. (U. S. Air Forces)*

The satellites should also tell scientists something about the composition of the earth. Some believe the earth's crust contains knots of material of exceptionally high density. Like a magnet, the gravitational attraction of these knots causes the waters of the ocean to swell above them. A Finnish geodesist has speculated that one such watery hill 150 feet high occurs in the North Atlantic.

If these knots really exist, the satellite should wobble a little as it passes over them. Ordinary mountains would not cause this. As a rule, they have less mass beneath them than flat land.

Who Fishes Most?

Japanese scientists, in estimating world fish production, state that Japanese fisheries produce 17 per cent of the entire world catch. Next in order of production is the U.S.S.R. The United States of America, formerly second, is now the third largest contributor to the world's fish harvest.

How Old Do Fish Grow?

By ROBERT W. ELLIS

Food and Agriculture Organization, U. N., Ecuador

HOW OLD is that big bluefin tuna or marlin, that battling tarpon or sporting salmon? How long do our favorite game and commercial fishes live? Many sports anglers as well as those who make a living by fishing would like to know the answers to these questions.

Age and growth studies today form an important part of the research program of any species of fish. The quest goes on in many parts of the world—with cod in the North Atlantic, salmon off the coasts of both North America and Europe, herring in Scotland, the mullet of Australia and the South African snook, to name only a few.

Early Measurements

Dr. C. G. T. Peterson, working in Denmark, found one of the early solutions to the fish-age problem. By measuring large numbers of fish and plotting the measurements on a graph, sometimes a series of peaks were noted, each of which indicated a separate year class. This method is satisfactory in a few species of fish, to separate the younger year classes. No distinct peaks are noted if the fish has a prolonged spawning time, that is, if two fish belonging to the same year class spawn several months apart. Therefore the Peterson method must be considered only a partial solution.

In 1892, C. Hoffbauer, a German scientist working on carp, re-examined observations made by 18th Century workers, who noted that scales and certain bones of fish were marked with rings. Hoffbauer thought that these rings might indicate annual growth, similar to the rings on the trunks of trees.

Rings Not Reliable

Many workers accepted this theory, and for some time it was believed that rings on scale and bony structures need only to be counted to find out the age of the fish. Modern workers still use scale-rings as a clue to age, but realize that, though false rings (perhaps caused by spawning activity) may sometimes be present, yet in other fish or under other conditions, the scales may lack annual rings.

The scales of some species of fish also rub off very easily, perhaps during handling or when they are caught in a net and are replaced by new ones. As a result, when scale samples are examined for rings, some may show clear spaces in the center. These are the replacement scales, and are of no use in age determination.

Scales Begin Soon after Hatching

In most species of fish, the growth of the scales and of some of the bony structures is roughly proportional to the growth of the fish. Scales are laid down very early in the life of a fish, soon after hatching. If the growth of the fish slows down or is checked, the

THE AUTHOR (RIGHT) AND ALFRED VOLPE *examine rings on the giant scales of tarpon as part of their study of fish growth rate. Scales begin to form very early in the life of a fish, and if the growth of a fish slows down or is checked, it will usually be indicated by changes in the intervals between growth rings on the scales. (Marine Laboratory, University of Miami)*

growth of the scale and other hard parts are similarly affected.

It is possible therefore to use this relationship to calculate the fish's growth at different times in its life by measuring the interval between rings on the scales. When water is at its warmest most fish feed actively and hence grow most rapidly. As water cools and food becomes scarcer, growth tends to slow down, and sometimes to stop altogether. This seasonal growth pattern causes broad and narrow bands to be laid down in the scales and other structures. The age is determined by counting either the broad or the narrow bands (usually the narrow ones).

Although rings can be clearly seen on the hard parts of a fish, tests must be made before it can be stated with certainty that these rings are true indicators of age. One test calls for plotting the lengths of a large number of fish on graphs and comparing the peaks on the graph with the average sizes of groups as determined from rings on the scales. Another widely-used test is that of studying scales taken at the time of tagging, and again

after recapture, to see if any rings have been added in the period between.

Changes in the appearance of scales of fish held in aquarium tanks have also been studied carefully as a check on the validity of age-determining methods. However, fish in aquaria sometimes develop abnormal growth patterns, because aquarium conditions differ so widely from those of nature.

Ear Bones Also Provide Answer

While scales usually are the most useful age-checkers, partly due to the ease with which they can be obtained and prepared for study, the otoliths or ear bones are often more suitable for this purpose. For example, the scales of the halibut show poorly defined marks, while twenty or more rings are clearly visible on the ear bones of this fish.

A Russian scientist found that rings on sectioned fin-rays also correspond with the age of cod as determined by other methods. Vertebrae are currently being studied at the Marine Laboratory, University of Miami, to find out the ages of the bluefin tuna.

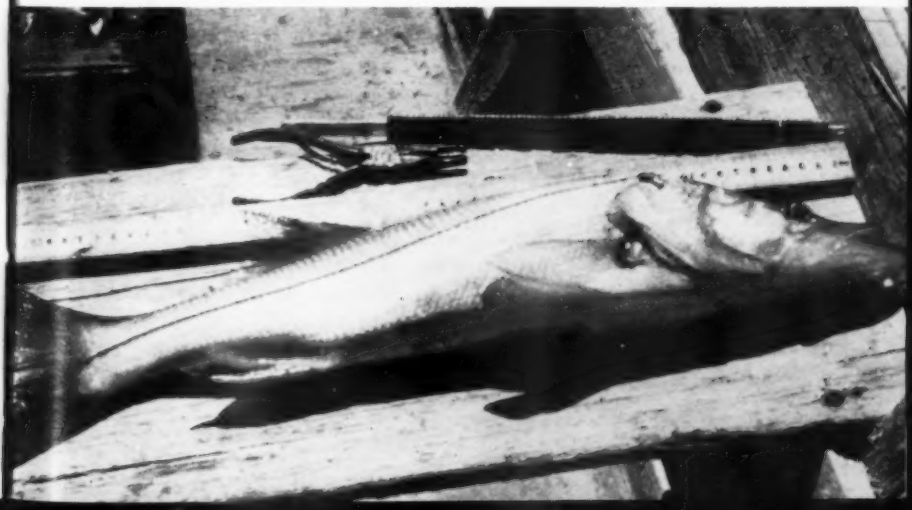
Shells of certain molluscs show rings which probably indicate seasonal growth. Workers studying seals and other marine mammals, in Canada and Norway, have developed a method of determining the ages of these animals by means of teeth sections.

Annual rings are most prominent on fish scales which show a marked seasonal growth pattern. Other, often migratory, species show a less marked pattern. For these, age determination is difficult and sometimes not possible at our present state of knowledge.

Do All Show Seasonal Growth?

Once it was believed that, because fishes of the tropics and warm temperate climates spend all of their lives

ONE OF THE EARLIEST APPROACHES TO *the fish-age problem was the measuring of large numbers of fish and plotting the measurements on a graph. Sometimes a series of peaks were noted, each of which indicated a separate year class. But this method is satisfactory in only a few species of fish. Here a live snook has been measured and a "cattle tag" applied to its gills. (Marine Laboratory)*



EXAMINING THE SCALES *of a recaptured tagged herring. It was first caught and tagged off Peterhead, northern Scotland, at the beginning of July, and then recaptured on Dogger Bank in September—a distance of 180 miles. In this particular experiment interest was chiefly in migration, but had the time interval been greater, clues to growth would have been obtained. (Central Office of Information)*

in warm water, no seasonal check in growth could be expected. While this may be true of some species, research workers have nevertheless found rings on the scales of such warm water fishes as mullet, tarpon and spotted weakfish, and have produced other evidence to suggest that these rings show annual growth. Also there is a considerable difference between mean summer and mean winter temperatures of the sea, even in sub-tropical areas. These differences apparently are great enough to affect the growth of fish.

Most of the common fishes studied so far have a comparatively short life by human standards. Fishes more than twelve years old are rare. This is partly due to the toll taken by fishing operations. Few fishes have a chance to die of old age. For haddock in the North Sea, it has been estimated that about 70 per cent of the marketable sizes are caught each year.

The following table shows what might happen to a million hatched fish during a period of ten years, most of the decline due to fishing:

Year	*Number Left At End of Year*
1	300,000
2	90,000
3	27,000
4	8,000
5	2,430
6	729
7	219
8	65
9	20
10	6

Fish stocks are subject to further attrition through injuries, pollution, and natural enemies, but these factors usually account for comparatively small percentages.

Go North, Young Fish

In some areas of the world, where fishing was started recently on stocks not previously exploited, the average age of fishes is much greater. This is true, for example, in the North Atlantic within the Arctic Circle. As fishing continues, however, the average age of fishes of the region will decline.

There are numerous difficulties in

finding out the maximum life span of any species of fish. The greater the number of rings on the scales, or on the ear bones, the harder it is to read the age. Growth slows down with age and the scales grow at the same lower rate. The rings on the edge of a scale of an old fish lie close together, and age cannot be determined with certainty.

Of species that have been studied intensively, the halibut is a real "oldster," with perhaps the maximum life span. This fish may live for more than twenty years. On the other hand, some well known food fishes, such as the North Sea whiting and herring, rarely live more than six years.

Redfish Declining?

As might be expected, if a species of fish is subject to heavy catches for commercial or sport purposes, slow-growing types are more likely to require protection by management laws than fast-growing fish. The former may be subject to exploitation and natural hazards before they spawn for the first time; thus the number of individuals in any year class are much reduced by the time that class is old enough to spawn.

The North Atlantic redfish, *Sebastes marinus,* appears to be in this category, and fishermen and scientists have been concerned about its apparently declining stocks in recent years. On the other hand, fast-growing fish usually spawn for the first time only a few years after birth, and hence stocks are less liable to depletion. The sailfish seems to be an example of a rapidly-growing fish.

Intensity of exploitation and the size at which the fish are caught also play important parts in stock survival.

Fishery Dynamics

To discuss another and related aspect of age and growth studies, it is necessary to introduce briefly the concept of fishery dynamics. The aim of fishery dynamics is to describe and measure the various factors that affect the abundance of fish and the interaction of these factors. Complex relationships between these factors can be expressed mathematically, but the

LOOKS LIKE A CROSS-SECTION *of a tree trunk, but it is really an enlarged photograph of the scale of a haddock, showing clearly the annual growth rings. While rings on most fish scales are not as reliable age-indicators as are the rings on the trunks of trees, they do reveal episodes in the lives of the individual fishes, and even periods when the water in which they lived became warmer or cooler. (Marine Laboratory, University of Miami)*

PUBLISHED RECORDS *and data, covering many years of work are used in order to describe and evaluate the various factors that affect the growth and abundance of fish, and the interaction of these factors. (Aberdeen Marine Laboratory)*

IN LABORATORIES SUCH AS THIS *in Aberdeen, Scotland, studies of fish scales, ear bones, and fin-rays are adding new chapters to our knowledge of the life span of fishes. (Aberdeen Marine Laboratory)*

present discussion will be confined to the statement of a simple theory.

This theory, as set down by E. S. Russell, an English worker, is as follows: If a stock of fish is to remain unchanged in weight, the sum of the rates of recruitment (the annual addition of young fish into the fishery) and growth which tend to increase the stock, must be equal to the sum of the rates tending to reduce it, namely, death due to fishing or natural causes.

This relationship can also be expressed as follows: Rate of fishing, plus rate of natural mortality, equals rate of recruitment, plus growth rate. A knowledge of the age of fish is essential in order to apply this relationship to fisheries management.

What is Optimum Catch?

Other variables in fisheries management can be calculated in various ways. When they are determined and substituted in equations of this type, the changes in abundance of stocks of fish can be studied. Such studies enable scientists to find out also the maximum amount of fish which can be safely removed from certain waters by fishing, the so-called "optimum catch," and yet still leave enough to maintain stocks at a high level.

Treatments of this sort are comparatively new in fisheries biology, but already considerable progress has been made in determining the optimum catch for some major fisheries, and the management methods which can be used to achieve this catch.

It will be seen, therefore, that scientists study the age of fish not merely to satisfy the interest of local anglers and commercial fishermen. A knowledge of the age of fish forms a vital tool in studies aimed at providing a maximum sustained yield in the future for the fisheries of the world.

THE RADAR PICKET SHIP, USS KRETCHMER, *takes a close look at a huge iceberg that has been spotted by planes of the Long Range Ice Reconnaissance. When an iceberg floats past the tip of Labrador, however, it becomes the responsibility of the International Ice Patrol, which tracks it constantly and warns vessels of 34 nations, including Russia, Great Britain, France, etc. (U. S. Navy)*

Stalking the Grey Ghosts

FROM NEWFOUNDLAND north to within 400 miles of the North Pole, the U. S. Navy relentlessly tracks, day after day during the spring, summer and fall months, one of the strangest foes ever hunted by a military organization—ice!

Aircraft squadrons based on the U. S. Naval Station, Argentia, Newfoundland, and at Keflavik, Iceland, patrol almost a million square miles of wild and lonely sea — stretching from the Denmark Strait, off Iceland, west to the edge of Hudson Bay, and from Argentia, in southern Newfoundland, north beyond the Arctic Circle.

Farther west, around Hudson Bay, the Royal Canadian Air Force, based on Resolute Bay in the Northwest Territory, covers an even wilder and more remote area. During their long range flights, both American and Canadian flyers make observations and obtain scientific data of value to oceanographers and meteorologists, as well as to the military.

Guard Vital Supply Line

The principal quarry of these intrepid flyers, however, is ice. Not only

the beautiful but deadly iceberg, only a part of whose immense bulk looms above the green water, but also the heavy ice flows which can block all navigation. Once spotted, an iceberg or a big ice flow becomes the focus of a series of rapid scientific computations. Data on size, position, and possible drift are flashed by radio to shore bases, which in turn translate them into courses and life expectancy, and then supply warnings to vessels of thirty-four nations, including Russia, Canada, Norway, France and Great Britain.

The lifeline of supplies to strategic U. S. and Canadian military outposts in the far north depends upon the successful efforts of these skilled U. S. and R.C.A.F. aviators. From the ice information gathered by their planes in lonely, hazardous patrols, weather officials can plot also the elusive and ever-changing ice-free shipping lanes, through which cargo ships must sail in order to replenish the supplies of Arctic bases during the short summer navigation season.

Ice Fields Logged

A trained aerographer, or Navy weatherman, flies as an ice observer on each patrol, sitting in the plexiglass nose of a twin-engine (P2V) aircraft. As the plane races along, he logs the size of the ice fields, spots the free areas, and notes their locations. Using a special set of symbols and color codes, he makes curious markings on the charts he holds in his lap. Various shadings spell out the sea ice formations in the areas over which the aircraft flies, and these shadings become a part of a coded message sent ashore.

New electronic devices aid the ice observers. A radarman is among the members of the eleven-man crew on the P2V's. Using modern radar equipment, he can map the boundaries of ice formations electronically. But the burden of the work still belongs to the weatherman in the nose of the plane, and the success of the operation still depends on the accuracy of his visual observations.

Long Range Ice Forecasts

From the information collected by the ice observers, the U. S. Navy Hydrographic Office, in Washington, D. C., is able to issue a long-range ice forecast for the entire season. It also

RADARMAN JERRY JONES, *an electronics-technician airman, U.S.N., locates ice boundaries and channels electronically, but the burden of the work still belongs to a trained aerographer, or Navy weatherman, who sits in the nose of the twin-engine (P2V) aircraft and visually spots ice fields and free areas. (U. S. Navy)*

ONLY DURING A FEW MONTHS *in the year can merchant ships penetrate icy seas to supply strategic U. S. and Canadian military outposts in the far north. For knowledge of the safest routes, these ships depend upon skilled U. S. Navy and R.C.A.F. aviators, who, on lonely hazardous patrols, plot the elusive and ever-changing ice-free shipping lanes. A cargo ship steams through pan ice in Baffin Bay, en route to bases at the top of the world. (U. S. Navy)*

releases thirty-day forecasts every fifteen days, and five-day forecasts weekly. In addition, daily forty-eight-hour operational ice forecasts are issued by the Fleet Weather Facility at Argentia, and by forecasters stationed at other bases farther north.

For those on the patrols, the operation does not exactly come under the head of fun. Overcast skies complicate the ice observer's work. The pilot must often skim the waves barely 50 feet above the water, in order to duck under fog and clouds, with the constant risk of nicking the jagged top of a berg. The weather over the entire area could hardly be considered resort-like, even in mid-summer. On a recent flight, the cabin heating system failed. While much of the rest of the world was enjoying warm June weather, temperatures inside the plane dropped to well below zero.

Can Survive Only 90 Seconds

The main thing is to keep aloft. A downed crewman can survive only 90 seconds in the bitter, ice-cold water without proper clothing; less than fifteen minutes even with the Navy's specially designed exposure suits.

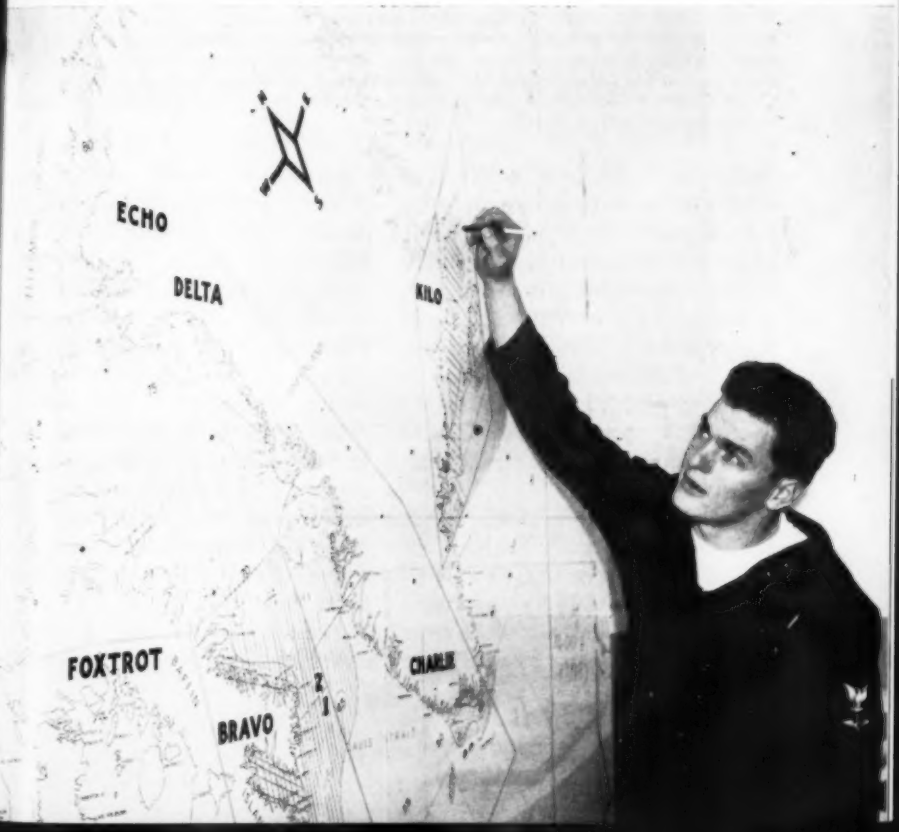
Probably there are few peacetime missions rendering a more valuable service, or subjected to such hazards. Even when a mission goes well, the cheeriest way to describe it is: "Too long, too cold." Veteran pilots complain of navigation problems in areas where charts are often inaccurate. A radioman talks of flying 50 feet above the ice and tells listeners: "I've flown in two wars. I'd rather fly combat any day than this."

But under the gripes of the crews is a sense of pride and teamwork that ties the men together and spurs them to constant fulfillment of their dangerous missions. Recently a P2V limped back 400 miles to safety with one engine gone. But the Navy has not lost a plane in the frozen Arctic wastes since 1954, the second summer of the patrol.

Ice Observers School

Ice observers attend a special Navy school at Lakehurst, New Jersey. The

DATA FLASHED FROM PLANES *of the Long Range Ice Reconnaissance patrol are plotted on a large map at the U. S. Naval Station, Argentia, Newfoundland. William S. Dorsch, aerographer's mate second class, U.S.N., jots down the latest information on ice conditions in area "Kilo," east of Greenland. The area names—Kilo, Echo, Delta, Foxtrot, Bravo, and Charlie—were chosen because they can be readily understood in a region where voice radio is often obscured by heavy static. (U. S. Navy)*



IT MAY LOOK DESOLATE TO YOU, *but Argentia is a mighty welcome sight to flyers returning from long, uncomfortable and hazardous ice patrols. Parked among the three dark U. S. Navy planes of the Long Range Ice Reconnaissance, whose missions sometimes take them within 400 miles of the North Pole, is a shiny U. S. Coast Guard PBIG (center), employed on the International Ice Patrol over north Atlantic waters. (U. S. Navy)*

rest of the plane crew, however, is trained for anti-submarine duty rather than ice patrols. At Argentia the same planes perform a dual mission. In addition to their flights 2,000 miles north in search of ice, the P2V's carry out regular anti-sub patrols, investigating reports of unidentified submarines in the North Atlantic and Grand Banks waters. Like Arctic ice patrols, submarine surveillance means around-the-clock vigilance.

Headquarters of the Long Range Ice Reconnaissance and Ice Forecasting Group is at Argentia, Newfoundland, where the submarine patrol flights and the vital Atlantic Barrier radar patrols are also supervised.

When Coast Guard Takes Over

However, when a big iceberg floats past the tip of Labrador, and escapes from the area watched by the P2V's, the U. S. Coast Guard air attachment at Argentia takes over. Flying the International Ice Patrol, the Coast Guard tracks all icebergs endangering regular shipping lanes in the North Atlantic, and radios the information to ships making trans-Atlantic crossings. As a result, disasters such as that which befell the *Titanic,* sunk with heavy loss of life after a collision with a huge iceberg, are hardly possible today.

The U.S. and R.C.A.F. ice patrols end each November, chiefly because

all far-north cargo shipping is halted during the winter. But with the arrival of spring, and the thawing of the ice pack, the Argentia aviators and ice observers are again on the job, providing invaluable information to surface shipping, so that our outposts may stay supplied.

Scientists, particularly meteorologists and oceanographers, welcome the data gathered by the ice observers as additional aids to the long-range forecasting of weather, and to the determination of the drift, speed and other characteristics of Arctic currents, about which little is known.

Bait From Vending Machines

Fishermen in Michigan will soon be able to get live bait at any hour of the day or night from roadside vending machines. A coin will deliver a dozen fathead minnows in a water-filled plastic bag. Bait is kept alive by a chemical solution that kills bacteria and neutralizes viruses and toxic effects of waste matter. Plastic bags let oxygen in, but don't let water out. The vending machines, which will need servicing only every five days, have a refrigerated storage dome filled with pure oxygen.

Sailfish "Dart Tag" Recovered

Catching sailfish off the Florida coast has become so commonplace that few specimens warrant more than the usual souvenir photograph at dockside, before going to the taxidermists. But one taken near Stuart by Mr. Francis Geiger, of Louisville, Ky., on September 15, 1958, deserves special mention.

His 7 foot 1 inch sailfish broke no records, but it bore a plastic streamer tag bearing the number 9999. This tag, of the "dart" design, had been applied 14 months earlier off Government Cut, Miami. Tagging and recovery areas are about 100 miles apart.

Records reveal that the sailfish was estimated to be 6 feet long, and to weigh 40 pounds at the time the tag was applied. At recovery, the fish measured 7 feet 1 inch. No weight was given at the time of recovery, but, as this is the first of the streamer tags to be recovered, the observation of a charter boat captain is important: "The tag was nicely imbedded and there was no indication of infection. In fact, the flesh and skin appeared well healed with just the streamer projecting." All of which is encouraging, and gives hope that more returns may be expected in the near future.

Watch For Tagged Tarpon!

By DR. JOHN E. RANDALL
The Marine Laboratory, University of Miami

MANY PEOPLE believe that the tarpon, silver flash of game fishes, wanders over vast distances; others insist its movements are limited.

Marine biologists agree that the most effective way to resolve this controversy is by tagging. A successful tagging program will not only document the movements of tarpon, but will give us much-needed data about growth.

Consequently, what will be the largest tarpon-tagging program ever undertaken has been launched by The Marine Laboratory of the University of Miami. That it is not one of the Laboratory's easier field projects is perhaps best indicated by the accompanying illustration. This large and rebellious tarpon, caught by W. Holloway at night in Boca Grande Pass, west Florida, is about to be tagged by the author, who at the moment is busily engrossed in the removal of the hook.

Shot of Tranquilizer

After gaffing the fish through the membranes of the lower jaw, it was anesthetized by spraying its gills with tricane methanesulfonate (MS-222). The big fellow was then hauled into the skiff, and its fork length (distance from tip of lower jaw, with mouth closed, to the end of the shortest central fin rays of the tail) accurately measured and recorded.

A "spaghetti" tag, consisting of a bright yellow soft plastic tube, with a center of sixty-pound test monofilament nylon, was passed through the back of the fish just behind the dorsal fin. The tagging was accomplished with the aid of a screw driver, the end of which had been sharpened to a point, and drilled with a hole the diameter of the tag.

Two of the large tough scales of the fish were taken from one side before the modified screw driver was passed through the back and two more were pushed off as it came through the other side. These scales were saved, in order that they might be compared with scales taken from the same fish if recovered at a later date. Such comparison is expected to confirm the aging of tarpon by counting the rings in the scales believed to be annular marks. Before the fish was released, the two free ends of the tag were pressed together with a monel clamp on which is stamped a number.

Save That Fish!

Printed directly on the yellow plastic is the inscription "Reward for Fish. Marine Lab, U. of Miami." Posters have been distributed to tarpon fishing centers requesting fishermen to take tagged tarpon to the nearest place of cold storage and contact The Marine Laboratory.

A total of 185 large tarpon were tagged with spaghetti tags in Boca Grande Pass during the fishing season

last summer. The author was ably assisted by Alan Moffett and Alfred Volpe, of The Marine Laboratory, and 14-year-old Phillip Bylaska, son of Ted Bylaska, well-known Boca Grande fishing guide.

I.O.F. member James M. Ingram, M.D. of Tampa tagged 12 additional tarpon at Boca Grande by placing strap tags on the gill covers. All of the tarpon were obtained from fishermen, after being brought to the side of sports fishing boats in the pass. The cooperation of these fishermen and local fishing guides is gratefully acknowledged.

Why Yellow Tags?

Yellow-colored tags will be used only in Boca Grande Pass; thus a fish which is lost after being brought close enough to a boat to positively see the tag and its color (which will in time be partially obscured by the growth of algae) can still provide valuable information on migration, providing The Marine Laboratory is informed of such an occurrence.

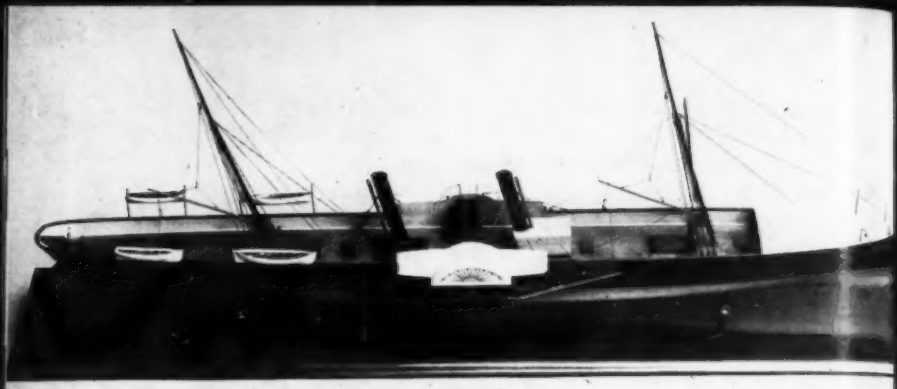
In 1939, 77 adult tarpon were tagged in Boca Grande Pass under the direction of Dr. C. M. Breder, Jr. of the American Museum of Natural History. Only one of these was ever recovered. This fish was caught 72 days later, 19 miles up the Myakka River from the pass. Strap and button tags were used, and apparently no fish, including others held in ponds, retained their tags longer than 258 days. Similarly, of 131 large tarpon tagged with dart tags by The Marine Laboratory in 1955-1956, only one was recaptured. It was taken 10 months later at Captiva Pass, 10 miles south of Boca Grande. The tag had just worked loose from the fish as it was boated.

It is believed that the spaghetti tag will be retained for much longer periods. A tarpon tagged with such a tag in September, 1957 and released in a pond in the Miami Seaquarium is still bearing its tag today!

It is hoped that it will be possible to continue tagging on a larger scale next year, for success in tagging depends not only on the development of a suitable tag, but also on placing tags on a great number of fish. In addition to tagging the large four to seven foot adult fish individually, efforts will be made to seine large numbers of smaller tarpon, two to three feet in length, for tagging.

This important program is sponsored jointly by the Florida State Board of Conservation and I.O.F. member Roger Firestone.

THIS LARGE TARPON, *balanced on the gunwhale of a Miami Marine Laboratory skiff, has just been quieted with an anesthetic (MS-222), administered with a battery syringe. The heavy fish, about to be tagged by the author, was caught by a sport-fisherman at night in Boca Grande Pass, on the Gulf coast of Florida. (L. Holloway)*



RUNNER OF THE WEATHER GAUNTLET. *Model of the unusual type of ships which ran the Union blockade of the Southern States during the American Civil War. Their daring skippers used oceanography, meteorology and other marine knowledge "in reverse," that is, they deliberately sought the darkest nights, the thickest or stormiest weather, and the seaports most beset by shoals, racing tides and other hazards. (Smithsonian Institution)*

They Sought Foul Weather

By PAUL H. OEHSER

PROBABLY NO SHIPS that sailed the high seas ever used oceanography, meteorology and other marine knowledge quite so much "in reverse" as did the swift blockade runners operated for the Confederate States of America.

Deliberately their daring skippers sought the darkest nights, the thickest or stormiest weather, and the seaports beset by shoals, racing tides and other hazards that any ship captain in his right mind would avoid. The bold seamanship of these adventurous men, who smuggled munitions and drugs into Southern ports and carried cotton outward bound, possibly prolonged the Civil War. In fact, they could have been a factor in winning it for the South, save for other heroes, largely unsung, who maintained the tedious Union Navy blockade, which tightened the noose on such clandestine commerce, and finally choked it off.

Greyhound of Steel

Those days of derring-do and of thrilling chases far into the night are recalled in a way by an excellent scale model of the fast blockade runner *Banshee,* lent by the City of Liverpool, England, and recently placed on exhibit in the marine transportation hall of the Smithsonian Institution in Washington.

Capable of 15 Knots

The *Banshee* is a good representative of an exciting era. She was one of the earliest steamers designed particularly for blockade running, and, built of steel, she was perhaps the first vessel constructed of this material to cross the Atlantic. Launched in Liverpool early in 1863, she began opera-

tions out of Nassau, Bahamas, in the summer of that year.

Capable of 15 knots in smooth water and 12 knots in a seaway, the sleek *Banshee* was a veritable ocean greyhound of her day. Like most of the type she pioneered, the *Banshee* was a two-stack side-paddlewheel steamer, long, narrow, and sharp-ended, and of shallow draft. She was built for Edward Lawrence & Co. of Liverpool by Jones, Quiggan & Co. of that port. The builders followed the *Banshee* with others of this type, becoming specialists in the construction of blockade-runners during the remaining years of the Civil War.

Telescoping Stacks

The *Banshee* had a short life in her trade, as was rather typical of blockade-runners. She was cornered by Federal cruisers after a long chase off Cape Hatteras on November 21, 1863, and later transferred into the U. S. Navy as a blockading cruiser. She was then pretty well worn out, having been perhaps too lightly built and having had very hard usage. She was sold in 1865 to private owners.

During her blockade-running career the *Banshee* had been most profitable. She cleared nearly 700 per cent of her cost for her owners, who replaced her in 1864 by a larger steamer of the same name, built on the Clyde.

The model, made in the builder's yard on a scale of 3/16 inch to the foot and in much detail, gives an excellent idea of the general appearance and proportions of these vessels. Some had telescoping stacks and all burned the best coal, to show little smoke.

Speeds up to 18 knots are claimed for some of the last blockade runners, but 12 to 15 was usually ample, for almost none of the Federal ships could reach such speed. In fact, few could reach 12 knots. The blockade runners were sometimes commanded by adventurous British naval officers on leave, and attracted reckless seamen. Although the danger was great, the pay was high.

The City of Liverpool Public Museums has permitted the Smithsonian Institution to make plans from this historic model. These, when complete, will be available to ship-model builders.

For Further Reading:

Running the Blockade, by Thomas E. Taylor. J. Murray, London; Scribners, New York (c.1896). This book describes some of the *Banshee's* adventures in detail.

Blockade; the Civil War at Sea, by Robert Carse. Rinehart, New York, 1958.

Two Christmas Islands, Neither Christmasy

There are two Christmas Islands—one a lofty British possession in the Indian Ocean, the other a huge atoll among the Line Islands of the Central Pacific, the National Geographic Society reports. Neither island is appropriately named, in North American terms, for white sand and coconut palms are the nearest approach to snow and evergreens. Both islands were christened by homesick mariners who sighted them at Yuletide.

Science of the Sea in Books

Books for the general reader are indicated thus, **(Gen.)**; those of interest chiefly to professional scientists, **(Pro.)**

PETER FREUCHEN'S BOOK OF THE SEVEN SEAS **(Gen.)**

PETER FREUCHEN WITH DAVID LATH. Julian Messner, Inc. New York, 1957. 512 pp. $7.50.

This is a big handsome book which may very well cover more different aspects of the sea than any published before. However, because of this attempt to discuss so much, the book left this reader disappointed at the shallowness and brevity of treatment of the individual subjects.

In ten parts, each (with one exception) having several chapters, Freuchen discusses The Shape of the Sea, Life in the Seven Seas, The Sea in Action, The Ships of the Seven Seas, The Great Voyages, Battles at Sea, Treasures of the Seven Seas. The Islands of the Seven Seas, The Law of the Seven Seas and Strange Tales from the Seven Seas. Certainly over this range, encompassing geology, oceanography, marine biology, seamanship, history, pirate lore, geography, law, mythology and goodness knows what else, no man can be expected to write with equal sureness or interest.

This fact is quite apparent, and there is a notable difference in the pace, authority and "tightness" when the author talks about things where he has personal experience. When he describes the Arctic, or ships, the writing comes much more alive than when he discusses science, or other subjects he knows second hand. Fortunately, the best passages of the book are absorbingly good.

A principal asset of the book is the numerous good illustrations. There are maps, drawings, photographs, and paintings in great and interesting variety.

The book lacks the lightness and humor that this reader had expected having seen Mr. Freuchen perform with grace and wit on television. Despite its faults, however, *The Book of the Seven Seas* is a good one, and will provide pleasure for many non-technical readers.

C.P.I.

ADVENTURING WITH BEEBE **(Gen.)**

WILLIAM BEEBE. Duell, Sloan and Pearce, Inc. New York. 1957. 283 pages. $4.50.

Although by no means a new book, "Adventuring With Beebe" is something that the fans of the famous explorer-naturalist-writer have wanted for some time—an anthology, his own selection, of Beebe's most dramatic science and adventure tales. Few men have lived such a varied life, and fewer still have the skill and imagination to describe their experiences in a way that the reader feels a part of them. This probably accounts for the perennial interest in anything that comes from Beebe's pen, and the devoted following he maintains among those who like to be entertained while being instructed. As for the scope of the anthology, it is best told by the author himself, in a foreword written at his laboratory in Arima Valley, Trinidad, where he now spends most of his time:

"These tales cover more than forty years of time," Beebe explains, "they range from Bermuda to British Guiana and the Pearl Islands, from the tops of lofty jungle trees to a half mile beneath the sea. They deal with varied wildlife, from black inchling fish which live in the eternal darkness

of ocean's abyss, to 35-foot whale sharks in full sun at the surface.

"They tell of birds, from the all but flightless hoatzin, to wandering albatrosses with wingspread of eleven feet. We shall become acquainted with all sorts of creatures; but whether butterfly, dolphin, lizard or snail, all are our neighbors through life and time on this good earth of ours, and hence traveling companions, whose lives it is a joy to watch and a privilege to share."

Running down the subject titles in the table of contents, the oceanographer might wish for a better proportion of marine articles, perhaps at the expense of some of Beebe's charming stories about birds, although Dr. Beebe was a noted ornithologist before he became an explorer of the deep sea. Perhaps he may be induced to give us a second anthology, predominately his writings about "Davey Jones's Locker," to which he was a pioneer personal visitor.

E. J. L.

THE FAMOUS BATHYSPHERE, *in which Dr. William Beebe (right) and Otis Barton made the pioneer personal explorations of the deep sea. Sponsored by the New York Zoological Society and the National Geographic Society, they descended to a then-record depth of 3,028 feet in the Atlantic Ocean, off Bermuda, in 1934. (New York Zoological Society)*

SEAFARERS AND THEIR SHIPS

(Gen.)

M. B. A. CHURCHARD, Ministry of Transport and Civil Aviation. Philosophical Library, New York. 96 pp., 23 illus. $3.75.

The development of the fo'c'sle of the merchant ship from the vile smelling, damp, illy lit and vermin-infested holes of the period of Midshipman Easy and Capt. Hornblower to the, by comparison, almost luxurious crew's quarters of the present merchant ship is no fluke of time and shipbuilding evolution. Instead it reflects the history of a long and hard fought battle by government agencies to protect and safeguard the lives and health of the men who man Britain's ships.

British ships put to sea on long ocean voyages with insufficient food of the lowest standards, scurvy was a common hazard of the British seaman's life and life boats were often mere ornaments, neither intended nor equipped for saving the lives of mariners at sea. British consuls complained that the officers and seamen of their nation's ships were of such bad moral character that they were jeopardizing their cargoes and even their nation's reputation by their antics in foreign ports.

The present volume, written to mark the centenary of the British Merchant Shipping Act of 1854, the first great step forward in Britain for safety and care of British seamen, is a history of the work of the Marine Department of the Board of Trade, now the Marine Division of the Ministry of Transport and Civil Aviation, and its fight for control and inspection of the merchant fleet.

As Sir Gilman Jenkins writes in the foreword, it is "one of the most inter-

esting stories of the evolution of the relationship between government and a great industry from early distrust and some antagonism, to the present happy state of mutual understanding and trust."

Readers interested in the sea, ships and the men who sail them will be interested in the accounts given of the various struggles for control of overloading of vessels, better safety regulations, the health of seamen and other aspects of sea life. Among them is the account of Mr. Plimsoll and his fight for loading limits. His name, now familiar to all, is commemorated by the Plimsoll line painted on the hull of every cargo vessel.

Safety at sea is introduced by the loss of the Titanic. The chapter on Conditions of Life at Sea well merits reading, as it is a documented account of the battle against scurvy and the introduction of lime-juice, the doling out of which to British sailors caused them to be known as "lime-juicers" or "limeys," a term which has continued in use among seamen to the present day. It was only by an Order in Council of April, 1927 that concentrated orange juice was sanctioned as an alternative.

Another important section is Safety Off the Shores of Britain, which gives an account of the origin of the Imperial Lighthouse Service, the Guild of Pilots which later formed the Pilotage Authority, and the organization and work of Her Majesty's Coastguard.

The book is well written in an interesting and informative manner, and every reader, British or others, who loves the sea, will enjoy reading and owning this little book. G.L.V.

STRANGE WONDERS OF THE SEA **(Gen.)**

Translated and adapted from J. Forest's *Beautes du fond des Mers* by GWYNNE VEVERS. Hanover House, Garden City.

If there be any lingering doubt about the astonishing variety of animal life in the sea, this handsome volume should dispel it. By means of 129 photographs, of which 32 are in full color, the reader is magically transported through the oceanic wonderland of the fishes, animal stars and flowers, coral and shells. Each of the book's five sections is preceded by a short commentary, giving interesting background related to the subjects that follow.

The method used in presenting the pictures and the captioning indicate that the editors intend that this book should be perused at leisure, chiefly for appreciation of the beauty and the fascinating shapes of the animals of the ocean world. The close-up photographs of the sea anemones, coral polyps and the microphotographs of animals in the plankton are high points. The color plates generally are very good, but at times the somber green and brown overtones destroy the underwater effect that one would like to see, and expects to see. These colors are somewhat disappointing to one who has visited the underwater world of the West Indies, where light-colored coral sand predominates.

Also disappointing are a number of photographs, static in nature, of nonliving animals completely removed from their habitat. A few will cut the nature photographer to the quick —the typical museum photograph, including two of a preserved octopus. It is unfortunate that, with the present wealth of underwater, seashore and aquarium photographs, that the same high quality could not have been maintained throughout the book.

The lack of identification of the color plates is at first disconcerting. The captions for these are gathered together in the back of the book. It may be assumed, however, that the

purpose of this arrangement was to give more page space to the pictures themselves, further evidence that these photographs were meant to be enjoyed at leisure, not simply glanced at.

All in all the book is well worth possessing, the superior quality of most of the material far outweighing the minor shortcomings.

—J. F. S.

FROGMAN V. C. **(Gen.)**

IAN FRASER. Angus & Robertson. 1957. 2 shillings.

This is the thrilling story of the four-man midget submarines, the XE-craft, used by the British during World War II to attack Japanese ships in the harbors of the Far East. Specifically it recounts the attack on the Japanese cruiser *Takao*, in Jahore Strait, by XE-3, commanded by the author.

Preliminary preparations for the attack, long months of training in England and Australia, towing to the area, and entrance through the Jahore Strait to the anchored ships, reads very much like well-written fiction. An exciting highlight is the interminable time spent by the midget submarine while she probes the bottom with barely enough room to move beneath the cruiser under attack.

The daring exit of the underwater swimmer to unfasten the 200 lb. limpet mines from the submarine and attach them to the bottom, the drop of the larger charges, only then to find that, with the ebbing tide, the submarine was caught between the bottom of the ship and the harbor, make for a gripping tale.

This is not the whole story. The author tells his experiences, almost his autobiography, from the time he enters Merchant Marine school as a boy, through the war, to the period of personal adjustment and the settling down to work after the war. One would suspect this last phase of the story was placed at the beginning by the editors to keep the best of the book—the submarine attack—to the end. Thus the first part of the book does not have the same high interest as the end.

One other facet of the story of Ian Fraser is revealed unintentionally. It is the struggle of the inner man who feels that he must have closer contact with the enemy and switches from merchant marine to destroyer, to large submarine, to midget submarine and frogman in this seeking. All in all, the book is an excellent one, although it gets off to a slow start.

J.F.S.

Big Russian Whaling Ship

Soviet Ukraine, Russia's biggest whaling factory ship, displaces 44,000 tons and her diesel engines provide 15,000 horsepower. Her holds can accommodate 2,000 tons of processed whalemeat, bones, etc. Facilities include TV for the crews, printing presses, and electric elevators that run up each mast. (See also "Politics and the Antarctic Whale," by G. H. Elliot, *Sea Frontiers*, Volume 4, No. 3, August, 1958.)

Progress

IN THE SHORT PERIOD of its life, *Sea Frontiers* has now reached a circulation of 15,000, not all of whom are members. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Denmark, Sweden and Norway, as well as a few from the Pacific Islands and the West Indies. Continued improvement will be possible with growth of active membership. It will be seen in better service, with more articles in the Bulletin of high interest and authenticity and, eventually, a monthly issue in full color.

Members are joined in these aims and they are urged to make progress possible by taking the small effort needed to enlist new members. To those who are not members, but whose interest and curiosity lie in the sea and the spirit of discovery, there is extended an invitation to participate by simply mailing a card. The ocean is our last frontier and its exploration still under way.

The editor will be glad to consider for publication articles and illustrations covering explorations, discoveries or advances in our knowledge of the marine sciences or describing the activities of oceanographic laboratories or expeditions in any part of the world.

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Qualifications for membership are an interest in the oceans and a desire to extend and develop scientific research and exploration into them. Support given to research through personal activities or donations is recognized by the Foundation through the following classes of membership. Members are those who make annual contributions of $5, Fellows $25 annually; Associates $100 annually; Life Fellows are those who contribute $200 or more or who have otherwise helped to advance the purposes of the Foundation; Sponsors who contribute $1,000 or more; and Patrons who contribute $5,000 or more. Corporate Associates contribute $1,000 annually.

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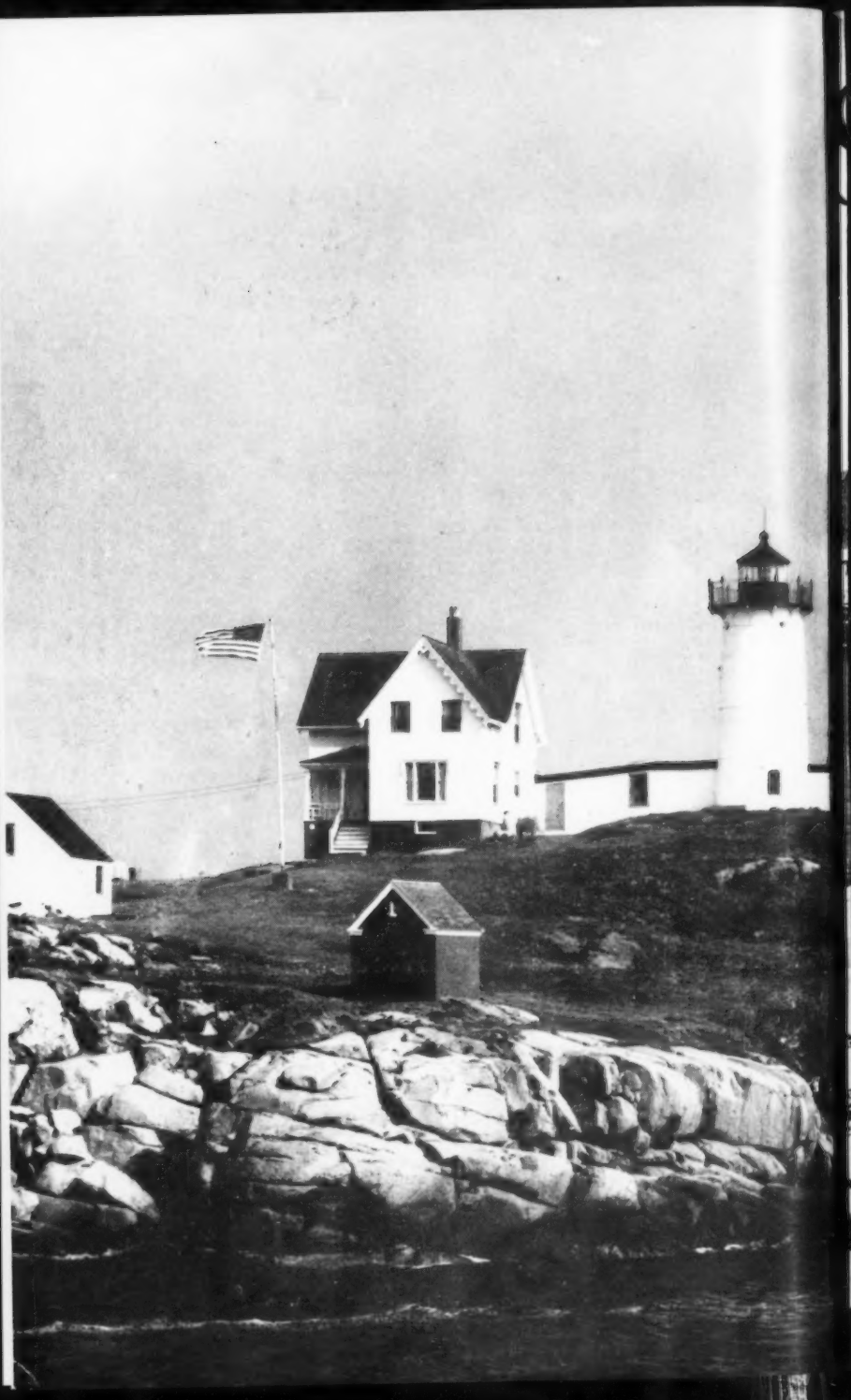
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